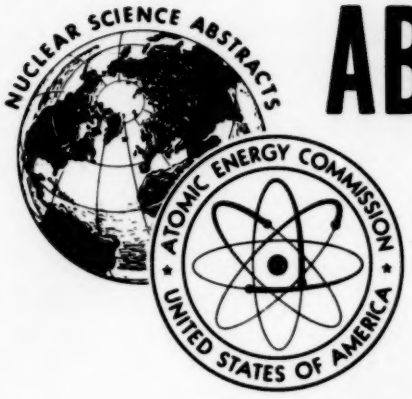
NUCLEAR SCIENCE ABSTRACTS



Volume 30 Number 1

Abstracts 1-2427

July 15, 1974

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Volume 30, Number 1, July 15, 1974

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

SMITH, H., Planetary nebulae: two types, 29:13374
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SMITH, J., See HOEGERMAN, S.F., 29:13035
See HOEGERMAN, S.F., 29:13037

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Problems on nuclear reactor structure at elevated temperature, 29:14654
REACTOR PROTECTION SYSTEMS
HTGR gas turbine power plant control and safety studies. Quarterly progress report for the period July 1, 1973--September 30, 1973, 29:14846 (GULF-GA-A-12799)

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14452 (WASH-1278) CTR ENGINEERING SYSTEMS STUDY REVIEW MEETING, GERMANTOWN, MARYLAND, SEPTEMBER 19 AND 20, 1973. Gough, W. C. **(USAEC Division of Controlled Thermonuclear Research, Washington, D. C.).** 1973. 258p. (CONF-730971-). Dep. NTIS $7.60.

is indexed as:

USAEC DIVISION OF CONTROLLED THERMONUCLEAR RESEARCH, WASHINGTON, D.C.
CTR engineering systems study review meeting, Germantown, Maryland, September 19 and 20, 1973, 29:14452 (WASH-1278)

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Volume 30, Number 1 July 15, 1974

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical and Separations Chemistry

1 NONDESTRUCTIVE DETERMINATION OF AREAL DENSITY AND TRITIUM CONTENT OF TRITIDED ERBIUM FILMS WITH BETA-EXCITED X-RAYS. Pearson, J.E. (General Electric Company, Neutron devices Department, St. Petersburg, Florida 33733). Appl. Spectrosc. 27: No. 6, 450-453 (Nov 1973).

The x-ray spectrum emitted from a tritided erbium film as a result of the beta decay is used to determine areal density and tritium content of the film. A Si(Li) detector and a dedicated minicomputer are used for detection, acquisition, and data reduction. The technique is suitable for areal densities of erbium from 0.01 mg/cm^2 to as high as 10 mg/cm^2. The occluded tritium can be measured from less than one to several hundred microliters. Precision is generally determined by counting errors and is typically less than 1% for a 5-min count while accuracy depends upon the empirical calibration technique. (auth)

2 GROWTH OF ANALYTICAL CHEMISTRY IN 1971 (SURVEY). Pilipenko, A. T.; Volkova, A. I. Ind. Lab. (USSR) (Engl. Transl.); 39: No. 5, 691-717(May 1973).

Translated from Zavod. Lab.; 39: No. 5, 513-536(May 1973).

The following topics are considered in this survey: extraction; new organic reagents; chromatography; ion exchange; atomic absorption and spectral methods of analysis; roentgenospectral and roentgenofluorescent analysis; neutron-activated and radiometric methods of analysis; electrochemical methods; concentration of microadditives; accuracy and sensitivity of analysis methods; and problems of analytical chemistry. A table of methods of determining and separating elements is included. (326 references) (LK)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 194, 219, 687, and 1031.

3 (FRNC-TH-467) INTRODUCTION OF ACTIVATION ANALYSIS INTO BOTANY: ANALYSIS USING A FAST NEUTRON ACCELERATOR-GENERATOR. Application to the Detection and Measurement of Pollution in Alpine Valleys. Examples of Images Obtained Using Recoil Protons. Garrec, J. P. (Grenoble-1 Univ., 38 (France)). 1970. 109p. (In French). Dep. NTIS (U. S. Sales Only) $8.50.

Thesis.

A systematic study was undertaken of the possibilities of activation analysis using fast neutrons (nondestructive analysis). The method was applied to measurements and control of the retention of pollutant elements by vegetation. Environmental pollution in the Maurienne valley resulting from the release of fluorinated gases by aluminum factories was studied. The pollution of water in the Isere valley by paper industries and radioactivity was also studied. The effects on underwater vegetation were simulated in laboratory pools. The absorption of Cs was studied using a stable activation tracer. A new method employing 14-MeV neutrons which utilizes neutrography techniques was also exposed. This method consists of detecting recoil protons formed in vegetable matter on radiographic film. (FR)

4 (UCRL-51499) AEROSOL TRACE ELEMENT ANALYSIS USING NEUTRON ACTIVATION AND X-RAY FLUORESCENCE. Roberts, N. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Feb 1974. Contract W-7405-eng-48. 127p. Dep. NTIS $5.45.

Thesis. Submitted to California State Univ., Hayward.

Throughout the year 1972, air filter samples were collected at Kellogg, Idaho, in the Coeur d'Alene mining district. These samples were analyzed to determine the concentrations of trace metallic elements in the air and to look for indications of their sources—for example, which ones are in the air as a result of the mining and smelting operations, and which are there "naturally" through being picked up by winds from the soil surface. The experimental procedures and results are given. The samples were analyzed for 34 elements with instrumental neutron activation analysis, and for six elements with x-ray fluorescence analysis. The enrichment of the element concentrations relative to their worldwide average concentrations in the earth's crustal rock is tabulated and discussed. Yearly average enrichment factors ranging from 0.845 to 901,000 were observed, and individual enrichment factors as high as 6,000,000 were noted. The elements observed are divided into three main groups according to their enrichment factors: those with low enrichment factors (<100), which are considered to be derived primarily from the soil; those with an intermediate enrichment factor (100 to 1000), which are considered to be of uncertain origin (soil and/or mining and smelting); and those with a high enrichment factor (>1000), which are considered to be clearly of mining/smelting origin. (auth)

5 NEUTRON ACTIVATION TECHNIQUE FOR THE ISOTOPIC ANALYSIS OF RHENIUM IN THE SUBNANOGRAM REGION. Michel, R.; Herpers, U.; Kukus, H.; Herr, W. (Univ., Cologne). J. Radioanal. Chem.; 18: No. 1-2, 177-185(1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

Neutron activation was applied to the measurement of the isotopic abundances of Re in lunar material. The activities induced by (n,γ) on ^{186}Re and ^{188}Re were determined by the γ rays of 137 and 155 keV, respectively. In order to avoid interferences (especially that of ^{198}Au and ^{99m}Tc) a procedure is needed which leads to a high radiochemical purity. The Re and W concentrations were also determined. An isotopic anomaly for Re was noted in the Apollo 14 samples showing a remarkable enrichment in ^{187}Re (from 1.4 to 1.8% in the soils and up to 29% in the breccia). It was shown that this enrichment is partially due to neutron irradiation on the lunar surface by the reaction $^{186}W(n,\gamma)^{187}W \xrightarrow{\beta^-} {}^{187}Re$. However, the anomaly observed, caused principally by intermediate neutrons, is not produced uniquely by lunar neutrons. Reactor activation contributes also by the reaction $^{186}W(n,\gamma)^{187}W \xrightarrow{\beta^-} {}^{187}Re(n,\gamma)^{188}Re$ which can be corrected by the analysis of W standards irradiated simultaneously. It was estimated that the lunar contribution to the enrichment of ^{187}Re is from 20 to 60% of the total excess observed. (tr-auth)

6 NEUTRON ACTIVATION ANALYSIS OF LUNAR SOIL SAMPLES OBTAINED BY LUNA 16 IN THE SEA OF ABUNDANCE. Surkov, Yu. A.; Kirnozov, F. F.; Ivanov, I. N.; Kolesov, G. M.; Rivkin, B. N.; Shpanov, A. P. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 169-176(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

The elementary composition of lunar regolite samples obtained by Luna 16 in the Sea of Abundance was determined by the radioactivation method using a neutron generator and a scintillation γ spectrometer with a Ge(Li) detector. (tr-auth)

7 ELEMENTAL ABUNDANCES OF LUNAR SOILS BY NEUTRON ACTIVATION ANALYSIS. Morrison, G. H.; Nadkarni,

R. A. (Cornell Univ., Ithaca, NY). J. Radioanal. Chem.; 18: No. 1-2, 153-167(1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

Neutron activation instrumental analysis and neutron activation analysis using chemical separations and high resolution γ spectrometry were used for the determination of 44 elements in lunar samples. If these methods are used in conjunction with spark mass spectrometry, more than 56 elements can be determined with a mean confidence of 10%. The results of the analysis of lunar soils reported by Apollo 11, 12, 14, 15, and 16 and by Luna 16 are compared. (tr-auth)

8 NEW METHOD FOR THE MEASUREMENT OF SPALLOGENIC ^{53}Mn BY NEUTRON ACTIVATION. Herpers, U.; Woelfle, R.; Herr, W. (Univ., Cologne). J. Radioanal. Chem.; 18: No. 1-2, 145-152(1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

Precise studies on long-lived and very scarce spallation nuclei produced by the interaction of cosmic rays and matter are of great interest for geochemistry and cosmochemistry. These reaction products are used for the study of the activity depth profiles and estimation of the radiation periods. ^{53}Mn is promising because of its relatively high production cross section and its long half life. The K-emitter nucleus is transformed by neutron capture into ^{54}Mn, which is easily measured by its γ ray. The advantage of this technique is that the level of activity is increased by a factor $>10^4$. The interferences due to (n,p) and (n,2n) reactions are studied systematically and corrected. The insufficiently known decay constant was studied by a partial transmutation of meteoritic ^{53}Mn into ^{54}Mn yielding stable ^{54}Cr by intense irradiation in a reactor for 587 days. The differences established in the production level of ^{54}Mn at the beginning and the end of the irradiation made it possible to determine the capture cross section as $\sigma_{53} = 66 \pm 7$ b. The products $T_{53} \cdot \sigma_{53} = (260 \pm 32) \times 10^6$ b leading to a decay period of $T_{53} = (3.9 \pm 0.6) \times 10^6$ yrs. The absolute quantity of ^{53}Mn produced in materials from the lunar surface is of the order of 2 to 7×10^{-2} g/g. (tr-auth)

9 APPLICATION OF ACTIVATION ANALYSIS TO THE EARTH SCIENCES. Morrison, G. H. (Cornell Univ., Ithaca, NY). J. Radioanal. Chem.; 18: No. 1-2, 9-20(1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

The domain of activation analysis and its applications to earth sciences are reviewed. These applications are classed as a function of the approach techniques used; among them are activation with thermal neutrons followed by radiochemical separation of the isotopes, neutron activation combined with γ spectrometry in the case of multielement analysis, and other activation methods. The exactitude of the values of activation analysis is compared in the case of selected elements in the U.S.G.S. standard diabase W-1. Activation analysis is also compared with other methods of trace analysis in the case of a moon sample. (tr-auth)

10 NEUTRON ACTIVATION INSTRUMENTAL ANALYSIS OF MONOMINERAL FRACTIONS AND REPRESENTATIVE GEOLOGICAL SAMPLES. Leipunskaya, D. I.; Savosin, S. I. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 21-30(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

An instrumental method was used for the analysis of monomineral fractions of sulfides from stannous ore zones, satellite minerals of the diamantiferous region of Yakoutsk, and auriferous ores. It is shown that the element composition of the sulfides in every series indicates the conditions for the formation of the deposits. It is established that the precision of the activation method for the analysis of Au is no less than that of the classic method and also permits the analysis of representative samples during the evaluation of Au reserves in the principal deposits. (tr-auth)

11 ANALYSIS OF THE CHEMICAL COMPOSITION OF FLUID INCLUSIONS BY NEUTRON ACTIVATION. Deschamps, N.; Sabouraud, C.; Bourrelly, I. N.; Touray, J. C.; Treuil, M. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 18: No. 1-2, 45-48(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

The possibilities of determining the chemical composition of fluid inclusions in intracrystalline cavities are described. As an example the application of the method to the measurement of the Cl/Br ratio in fluid inclusions of gypsums of marine origin is described. (tr-auth)

12 NEUTRON ACTIVATION ANALYSIS OF V, Cr, Hf, Zr, Tl, Rb, and Cs IN CLAYS, ZIRCONS, AND FELDSPARS. Jaffrezic, H. (CNRS, Vandoeuvre-les-Nancy, France); Decarreau, A.; Carbonnel, J. P.; Deschamps, N. J. Radioanal. Chem.; 18: No. 1-2, 49-53(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

Some examples are given of the application of neutron activation analysis to the study of geochemical problems: 1) distribution of rare alkalines and Tl in feldspars; 2) measurement of the Zr/Hf ratio in zircons; and 3) determination of V in clays. The three types of rocks or ores studied illustrate well the flexibility of this method. (tr-auth)

13 ANALYSIS OF LANTHANIDES, Hf, Sc, Cr, Mn, Co, Cu, AND Zn IN ORES AND ROCKS BY NEUTRON ACTIVATION. Treuil, M. (Univ., Orleans, France); Jaffrezic, H.; Deschamps, N.; Derre, C.; Guichard, F.; Joron, J. L.; Pelletier, B.; Novotny, S.; Courtois, C. J. Radioanal. Chem.; 18: No. 1-2, 55-68(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

For the best utilization of the possibilities of activation analysis and γ spectrometry using semiconductor detectors rapid separation schemes are proposed. These schemes make possible routine analysis of lanthanides, Sc, Cr, Mn, Co, Cu, and Zn in the majority of ores and rocks with a precision between 3 and 10%. The method was applied to a wide variety of samples and tested on standards. Examples are cited to show that the method can be used in the systematic geochemical study of transition elements. (tr-auth)

14 USE OF PHOTONUCLEAR ACTIVATION REACTIONS AND NEUTRON PRODUCTION PHOTONEUTRON REACTIONS FOR THE SYSTEMATIC AND HIGHLY SENSITIVE INSTRUMENTAL ACTIVATION ANALYSIS OF ORE AND MINERAL SAMPLES. Sulin, V. V. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 69-83(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

It is shown from the results of irradiation of polymetallic samples and W-Mo ores and of alkaline and other ores by γ quanta and photoneutrons that it is possible to identify the activation products of the neutron and photonuclear reactions of 21 elements (from F to Pb). The principal mixing and irradiation conditions of the samples in bremsstrahlung and photoneutron irradiation are discussed for the simultaneous analysis of 2 to 8 elements with a sensitivity threshold of 0.1 ppm (in wt. % it is from 0.001% to 0.00001% for Cu, Mo, W, Au, etc. and only 0.1 wt. % for Fe and Ca). (tr-auth)

15 STUDY AND DEVELOPMENT OF ACTIVATION METHODS FOR THE DETERMINATION OF Au, Ta, AND Sc IN SAMPLES OF NATURAL MATERIALS. Pchelkin, V. A.; Sviderskii, M. F.; Grinberg, L. L.; Burmistenko, Yu. N.; Feoktistov, Yu. V. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 85-96(1973). (In French).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

Activation analysis methods for the determination of Au, Ta, and Sc in rocks, ores, and minerals are described. A nuclear reactor and a powerful linear accelerator are used for activation. (γ,γ) reactions were also used for the determination of Au and (γ,n) reactions for the determination of Ta. In a reactor thermal neutron flux Au, Sc, and Ta were determined by (n,γ) reactions using radiochemical separation of the isotopes. (tr-auth)

16 NON-DESTRUCTIVE PHOTON-ACTIVATION ANALYSIS OF STANDARD ROCKS WITH 30 MeV BREMSSTRAHLUNG. Kato, T. (Tohoku Univ., Sendai); Morita, I.; Sato, N. J. Radioanal. Chem.; 18: No. 1-2, 97-110(1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

Photon activation analysis was applied to the non-destructive analysis of USGS standard rocks. 16 elements were determined. The rock sample and the multielement standard were irradiated simultaneously in 30-MeV bremsstrahlung and the activity of the radioisotopes produced by (γ,n) and (γ,p) reactions were measured with a Ge(Li) detector. The validity of the method is shown by the results obtained for these rocks. Results were obtained for Na, Mg, Ca, Ti, Cr, Mn, Fe, Co, Ni, Rb, Sr, Y, Zr, Nb, Ba, and Ce. (tr-auth)

17 NEUTRON ACTIVATION ANALYSIS OF SOILS. Buenafama, H. D. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 111-118(1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

The analysis of soils by neutron activation using a high resolution Ge(Li) detector for the detection of 31 elements was described. The elements determined include the alkaline earth metals, rare earths, and transition elements. The majority of them are used as indices of geochemical differentiation and others are used as nutrition factor in plant physiology. Some elements, Na, K, Rb, Cs, Ba, La, Ce, Sm, Eu, Th, Zr, Hf, Ta, Mn, Co, Fe, Sc, Cr, Sb, Ca, V, Al, Ti, Br, and U, were determined by non-destructive γ spectrometry and others, Mo, W, Sr, Cu, Zn, and Ga, after a simple radiochemical separation based on ion exchange and solvent extraction. Epithermal neutron activation was used for the determination of U, using reactor neutrons. The risks of interferences in the reactions and in the γ spectra, autoabsorption, and other possible causes of error are analyzed and evaluated when possible. The results are given as averages of several determinations. There is great precision in all cases. (tr-auth)

18 DETERMINATION OF TRACE ELEMENTS IN PETROLEUM AND PETROLEUM FRACTIONS BY THE NEUTRON ACTIVATION METHOD. Berkutova, I. D.; Vlunova, E. S.; Jalnina, T. I.; Zlotova, I. M.; Yakubson, K. I. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 119-132 (1973). (In Russian).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

The basic characteristics of methods used for the analysis of petroleum are described. The distribution of a series of trace elements in petroleum fractions is studied. The usefulness of interpreting the results on the Co and As concentration for correlations and differentiations of petroleum in geological and geochemical studies is shown. (tr-auth)

19 DETERMINATION OF TRACE TRANSITION ELEMENTS IN ULTRA HIGH PURITY SODIUM AND CALCIUM CARBONATES BY NEUTRON ACTIVATION ANALYSIS. Mitchell, J. W.; Riley, J. E.; Northover, W. R. (Bell Telephone Labs., Inc., Murray Hill, NJ). J. Radioanal. Chem.; 18: No. 1-2, 133-143 (1973).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

^{64}Cu and ^{56}Mn in ultrapure Na_2CO_3 were determined by γ spectroscopy after elimination of ^{24}Na by passage on columns of hydrated antimony pentoxide (PAH). Co, Cr, and Fe were also determined by nondestructive spectrometric detection of the γ radiation of ^{60}Co, ^{59}Fe, and ^{51}Cr. In the case of $CaCO_3$, after irradiation and dissolution, ^{64}Cu and ^{56}Mn were determined simultaneously by a selective radiochemical separation at pH 3 to 4 with a mixture of dithizone (H_2D) and pyrrolidindithiocarbamic acid (HPDC) in $CHCl_3$. The radioactive interference of ^{47}Sc and ^{47}Ca produced during 100 hrs of irradiation of $CaCO_3$ was suppressed by its selective extraction in 5.0 M HCl by the oxide of tri-n-octylphosphine (TOPO) 0.1 M in cyclohexane. A mixture of 0.1 M thenoyltrifluoroacetone (HTTA) 0.1 M TOPO in cyclohexane was used to remove ^{47}Ca at pH $\geq$ 8.0. After elimination of the activity of the matrix isotopes the photoelectric peaks of ^{59}Fe, ^{60}Co, and ^{51}Cr were measured to determine these impurities. (tr-auth)

20 MULTIELEMENT ANALYSIS OF MINERALS BY NEUTRON ACTIVATION ANALYSIS AND FLUORESCENCE AND BY USE OF SEMICONDUCTOR DETECTORS. Zaitsev, E. I.; Sotskov, Yu. P. (Commission of Atomic Energy, Moscow). J. Radioanal. Chem.; 18: No. 1-2, 31-44(1973). (In Russian).

From international colloquium on activation analysis of very low amounts of elements; Saclay, France (2 Oct 1972).

The methods and techniques of the activation analysis of ores for the determination of rare elements from their long-lived isotopes are studied. The evaluated precision, sensitivity, and yield for the determination of Ta, Cs, Hf, Sc, and Sb are given. The necessity of combining the methods of neutron activation analysis and x fluorescence in geochemical studies is shown. (tr-auth)

21 CONCENTRATION OF ZINC IN SUBCELLULAR FRACTIONS OF MALIGNANT MELANOCYTES. Carlson, G. O. (Karolinska Institutet, Stockholm). Sv. Tandlakareforb. Tidn.; 66: No. 3, 281-294(1973).

Subcellular fractions from three different strains of malignant melanocytes were analyzed by means of neutron activation analysis. The amount of zinc was estimated in each fraction and the nature of every fraction was verified by means of electron microscopy. The concentration of zinc was invariably highest in the ribosome fraction except for one subject. The reliability of the method was tested by double examinations and the estimated mean recovery was 92.0%. (auth)

22 CONCENTRATION OF COPPER AND ZINC IN THE ORAL MUCOUS MEMBRANE. Carlson, G. O. (Karolinska Institutet, Stockholm). Sv. Tandlakareforb. Tidn.; 65: No. 2, 79-83(1972).

The concentrations of the trace metals copper and zinc in normal oral mucous membrane of man, calculated by neutron activation analysis are reported. The copper concentration was found by measurement to be 5.1 ± 1.7 and zinc 60 ± 17 ppM dry weight. A comparison with oral mucous membrane of white mouse shows close conformity. A study of the error of the method shows that the described biopsy procedure can be used without increase of the risk of contamination. (auth)

23 METHODS OF DETERMINING ISOTOPES OF INDUCED ACTIVITY. I. Determination of Radioisotopes of Manganese. Rovinskii, F. Ya.; Iokhel'son, S. B.; Yushkan, E. I.; Sycheva, M. D. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 273-276(1973).

Translated from Radiokhimiya; 15: No. 2, 274-276(1973).

A radiochemical method was developed for isolating manganese isotopes from soil samples containing fission and activation products. Gamma-spectrometric analysis methods were used for quantitative determinations of ^{54}Mn and ^{56}Mn. (auth)

24 METHODS OF DETERMINING ISOTOPES OF INDUCED ACTIVITY. II. Determination of Radioisotopes of Iron. Rovinskii, F. Ya.; Iokhel'son, S. B.; Yushkan, E. I.; Sycheva, M. D. Sov. Radiochem. (Engl. Transl.): 15: No. 2, 277-279(1973).

Translated from Radiokhimiya; 15: No. 2, 277-278(1973).

A method was developed for the radiochemical isolation of ^{59}Fe and ^{55}Fe from soil samples containing fission fragments and products of activation reactions. The chemical yield was determined taking into account the stable iron content of the sample. The ^{59}Fe was determined from the spectrum of the nuclear gamma-radiation of the preparation; the ^{55}Fe was determined from the x-ray spectrum of its daughter isotope ^{55}Mn. (auth)

25 METHODS OF DETERMINING ISOTOPES OF INDUCED ACTIVITY. III. Determination of Radioisotopes of Cobalt. Rovinskii, F. Ya.; Iokhel'son, S. B.; Yushkan, E. I.; Sycheva, M. D. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 280-281(1973).

Translated from Radiokhimiya; 15: No. 2, 279-280(1973).

A radiochemical method was developed for isolation of radioisotopes of cobalt from samples containing fission fragments and activation products. The reagent α-nitroso-β-naphthol was used for the isolation of the cobalt. A gamma-spectrometric method is described for determining ^{57}Co and ^{60}Co in preparations containing a mixture of these isotopes. (auth)

26 ANALYSIS OF SMALL BIOPSY SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Betra, G. J.; Bewley, D. K. (Hammersmith Hospital, London). J. Radioanal. Chem.; 16: No. 1, 275-280 (1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

An accurate knowledge of the ratio Ca/P in bone biopsies is very useful in the diagnosis of osteoporosis. Similarly, measurements on muscle biopsies are important in understanding the disturbance of intracellular fluid and electrolyte (Na, Cl, K, and P) balance in patients with metabolic myopathies (muscle diseases) and acid-base disturbances including renal failure. The ratio Ca/P in normal subjects was found to be 2.30. Similarly, the ratio K/P was found to be very nearly constant in normal subjects. (auth)

27 RADIOCHEMICAL SEPARATIONS BY ADSORPTION ON SOME OXIDES OF GROUPS IVB AND VB. Ganzerli-Valentini, M. T.; Meloni, S.; Maxia, V.; Pisani, U. (Univ., Pavia, Italy). J. Radioanal. Chem.; 16: No. 1, 191-204(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The interactions between titanium dioxide, niobium pentoxide, and tantalum pentoxide and 55 elements were studied by batch experiments in nitric acid. The variation of the distribution coefficients with nitric acid concentration is presented and discussed. The adsorption mechanism for some ions has also been investigated. Column experiments were carried out to check the practical use of the investigated oxides in radiochemical separations. A ^{99m}Tc generator based on the use of TiO_2 is also presented. (auth)

28 SEPARATION OF RADIONUCLIDES BY ISOTOPIC EXCHANGE USING METAL CHELATES AND FIXED METAL SULFIDE PRECIPITATES. Banyai, E.; Gimesi, O.; Farkas, A. (Technical Univ., Budapest). J. Radioanal. Chem.; 16: No. 1, 173-181(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The possibilities of radioanalytical separation by isotopic exchange with metal chelate complexes and metal sulfide precipitates fixed in paper have been examined on the model system $^{203}Hg^{2+}$ + $^{65}Co^{2+}$ + $^{65}Zn^{2+}$ + $^{24}Na^{+}$. (auth)

29 SUBSTOICHIOMETRIC DETERMINATION OF TRACE IMPURITIES IN HIGH-PURITY MATERIALS BY RADIOACTIVATION ANALYSIS. Kudo, K.; Shigematu, T.; Iso, H. (Nippon Telegraph and Telephone Public Corp., Ibaraki, Japan). J. Radioanal. Chem.; 16: No. 1, 139-151(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The substoichiometric determination of some impurities in gallium arsenide and selenium supplied by OEC and IUPAC, respectively, as reference materials for radioactivation analysis is described. (auth)

30 AUTOMATED CHEMICAL SEPARATIONS IN ROUTINE ACTIVATION ANALYSIS. Tjioe, P. S.; de Goei, J. J. M.; Houtman, J. P. W. (Interuniversity Reactor Inst., Delft, Netherlands). J. Radioanal. Chem.; 16: No. 1, 153-164(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

In recent years increased information is required about the distribution of elements at low concentration levels in the biosphere. Neutron activation analysis can play an important role if it can supply many data at relatively low cost. As some of the concentrations are too low for determination by non-destructive techniques, equipment for chemical separations on a routine basis is necessary. For environmental studies a separation scheme has been developed successfully for arsenic, antimony, cadmium, copper, mercury, selenium, and zinc. It is based on a combination of distillation and ion-exchange. Special attention is paid to the prevention of interference from bromine and sodium. Additional information about chromium, cobalt, nickel, and tungsten can easily be obtained. Experience gathered with an automated instrument for fifty samples a week is described. (auth)

31 USE AND AUTOMATION OF MULTIELEMENT SUBSTOICHIOMETRIC EXTRACTION OF METAL CHELATES IN ACTIVATION ANALYSIS. Elek, A. (Central Research Inst. for Physics, Budapest). J. Radioanal. Chem.; 16: No. 1, 165-172 (1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A solvent extraction method based on the substoichiometric separation principle is presented. The separation conditions are discussed. Automated procedures were developed for the group extraction of mercury and silver dithizonates and of mercury, copper, antimony, and arsenic diethyldithiocarbamates. (auth)

32 RADIOANALYTICAL INVESTIGATION ON RHODIUM EXTRACTION BEHAVIOR WITH TRI-N-BUTYLPHOSPHATE FROM IODINE SOLUTIONS. Stella, R.; Di Casa, M. (Univ., Pavia, Italy). J. Radioanal. Chem.; 16: No. 1, 183-190(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Radioanalytical techniques were used in this work to investigate the extraction behavior with TBP of rhodium(III) chloride solutions to which a large excess of iodide is added. Extraction yields and distribution coefficients were determined as a function of $HClO_4$ or H_2SO_4 content in the aqueous phase. Rhodium-stripping from the organic phase with ammonia solutions was also tested. Neutron activation analysis was used to measure the extraction efficiency. (auth)

33 RADIOCHEMICAL DETERMINATION OF TRACE NOBLE METALS IN SILVER ARTEFACTS. Randle, K.; Wellum, R.; Whitley, J. E. (Scottish Universities Research and Reactor Centre, Glasgow). J. Radioanal. Chem.; 16: No. 1, 205-214 (1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Radiochemical separations are essential for the determination of trace elements in silver artefacts by neutron activation analysis due to the high levels of both short and long-lived activities produced by the matrix, but the sensitivity of the technique permits the examination of small samples. The noble metals are considered most significant from a diagnostic standpoint, and radiochemical techniques were developed for their determination in samples of a few milligrams. Methods were investigated for the determination of Pd, Rh, Ir, and Pt in samples removed from museum specimens of known provenance. (auth)

34 STUDY OF ION-EXCHANGE SEPARATIONS IN TARTARIC ACID MEDIUM AND APPLICATIONS TO ACTIVATION ANALYSIS. Rouchaud, J. C.; Revel, G. (CECM, Vitry, France). J. Radioanal. Chem.; 16: No. 1, 221-226(1973). (In French).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The distribution coefficients of Ag, As, Au, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Hf, In, Mo, Mn, Ni, Nb, Sb, Sc, Ta, Pa, W, Zn, and Zr were determined for Dowex 50X8 and Dowex 1X8 resins in tartaric acid medium. These determinations lead to their practical application in activation analysis. A comparison is given with other generally used acidic media. (auth)

35 APPLICATION OF DISPLACEMENT EXTRACTION CHROMATOGRAPHY IN ACTIVATION ANALYSIS. Alimarin, I. P.; Yakovlev, Yu. V.; Stepanets, O. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). J. Radioanal. Chem.; 16: No. 1, 227-233(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A method based on exchange reactions of metals with coordination compounds and termed displacement extraction chromatography is proposed. The method consists essentially in the successive displacement of elements with lower extraction constants, present in the form of coordination compounds in the organic phase on the column, by substoichiometric amounts of elements with higher extraction constants, admitted to the column in aqueous solution. The method was used to determine various contaminations in yttrium, molybdenum, zirconium, niobium, and beryllium by activation analysis. (auth)

36 APPLICATION OF ION EXCHANGERS AND INORGANIC FILTERS TO THE DETERMINATION OF SELENIUM AND TELLURIUM IN COPPER. Mignonsin, E. P.; Guillaume, M. (Univ., Liege). J. Radioanal. Chem.; 16: No. 1, 235-243(1973). (In French).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Selenium and tellurium isotopes formed by thermal neutron irradiation have longer half-life than the copper isotope. The nondestructive analysis fails even after the complete decay of copper because of the other radioisotope present. The radioisotopes were separated by ion exchange chromatography on Dowex 1X8 (200–400 mesh) and "Peritanic" resins in order to obtain a highly sensitive analysis. The limits of detection of 5 ppB for tellurium and 0.5 ppB for selenium were obtained. (auth)

37 INVESTIGATIONS ON THE PREPARATION AND APPLICATION OF SOME INORGANIC SEPARATORS FOR THE REMOVAL OF THE MATRIX ACTIVITY IN NEUTRON-ACTIVATED BIOLOGICAL SAMPLES. Nagy, L. G. (Technical Univ., Budapest); Toeroek, G.; Foti, G.; Toth, T.; Feuer, L. J. Radioanal. Chem.; 16: No. 1, 245-255(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

For the selective removal of the matrix activity (^{24}Na, ^{32}P, and ^{42}K) in the neutron activation analysis of biomedical samples the inorganic separators "hydrated antimony pentoxide," zirconium phosphate, and titanium phosphate were prepared. The sorption parameters of the samples were determined via elution chromatography techniques, with appropriate tracers. The basic principles of the sorption processes were investigated, and the experimental conditions were optimized. These inorganic separators were then applied, combined with a distillation procedure and an ion-exchange separation, for the determination of the following trace elements in animal blood samples: Mn, Co, Cu, Fe, and Zn. (auth)

38 ACTIVATION ANALYSIS OF MERCURY IN BIOLOGICAL SAMPLES. Kim, J. I.; Sunoko, S. R. (Institut fuer Radiochemie, Munich). J. Radioanal. Chem.; 16: No. 1, 257-267(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A method was developed for the determination of trace quantities of mercury in biological samples, in which homogeneous irradiation was achieved by introducing a rotating irradiation disk facility in the reactor pool water, and possible loss of mercury during chemical processing was reduced by using a simple procedure. This procedure involved the destruction of the sample in a reflux system with conc. HNO_3 or fuming $HNO_3 + H_2O_2$ and subsequent isolation of mercury by spontaneous deposition on Cu sieves from dilute HNO_3 (0.5–1.5 N). The possibility of using Au or Co as standards, instead of mercury which is easily volatile, was also evaluated. (auth)

39 DETERMINATION OF Cs, Rb, AND Ba IN NEUTRON-ACTIVATED BIOLOGICAL MATERIALS. Buenafama, H. D.; Rudelli, M. D. (Comision Nacional de Energia Atomica, Buenos Aires). J. Radioanal. Chem.; 16: No. 1, 269-273(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The determination of Cs, Rb, and Ba in biological materials, including human bones, eggs, milk, meat, and vegetables by neutron activation analysis is described. The proposed technique is based on the measurement of the long-lived radioisotopes ^{131}Ba, ^{134}Cs,

and ^{86}Rb with a Ge(Li) detector, after a simple radiochemical separation based on selective retention of these nuclides on HAP in 6M HF. Detection limits of 0.001 ppM can be achieved with 5% precision. Data are given for replicate determinations in six different types of materials. (auth)

40 POSSIBILITIES AND LIMITS OF NEUTRON ACTIVATION ANALYSIS OF MULTI-ELEMENTS IN BIOLOGICAL SAMPLES WITH AND WITHOUT SEPARATION OF THE ACTIVATED MATRIX. Maziere, B.; Gaudry, A.; Stanilewicz, W.; Comar, D. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 16: No. 1, 281-196(1973). (In French).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The possibilities and limits of the multi-elemental determinations in biological samples by neutron activation analysis with and without chemical separation are discussed. (auth)

41 APPLICATION OF THE 30-MeV MICROTRON FOR GAMMA AND NEUTRON ACTIVATION ANALYSIS. Kapitsa, S. P.; Melekhin, V. N.; Samosyuk, V. N.; Tsipenyuk, Yu. M. (Inst. of Physical Problems, Moscow). J. Radioanal. Chem.; 16: No. 1, 297-305(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Based on studies of variable multiplicity electron acceleration, the power-current microtron, a cyclic electron accelerator up to energies of 30 to 35 MeV was developed at the Institute on Physical Problems of the Academy of Sciences of the USSR. The 1 to 1.5 kW electron beam of the microtron is comparable to the power output of modern linear accelerators operating at similar energies. At the same time, the microtron has a number of significant advantages, due to the simplicity of design of both accelerator and ultrahigh-frequency tract, the high efficiency of ultrahigh-frequency power utilization, good operating characteristics, strictly monochromatic electron beams (variations not exceeding ±50 keV at 30 MeV) and the possibility of continuously changing particle energy as required by the given experimental task. (auth)

42 QUANTITATIVE EVALUATION OF THE PHOTON-ACTIVATION METHOD IN ANALYSIS. Kato, T. (Tohoku Univ., Sendai). J. Radioanal. Chem.; 16: No. 1, 307-327(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Yields of the photonuclear reactions of various types induced in 71 elements were determined experimentally by means of bremsstrahlung irradiation with different maximum energies, and detection of the resultant activities with a lithium-drifted germanium detector. From the results obtained, sensitivities in photon-activation analysis were evaluated and the reactivity of high-energy photons with nuclei in a wide range of atomic number were discussed. (auth)

43 USE OF NON-DESTRUCTIVE HIGH ENERGY GAMMA PHOTON ACTIVATION FOR TRACE ELEMENT SURVEY ANALYSIS. Hislop, J. S.; Williams, D. R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Radioanal. Chem.; 16: No. 1, 329-341(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

An empirical study was made of the potential of high energy γ-photon activation and high resolution γ spectrometry for the survey analysis of trace elements in a variety of materials. Human blood, urine, bone ash, standard glass (NBS, SRM 612) and air particulates, along with synthetic multi-element standards, have been studied following irradiation with γ photons of maximum energy 17 to 45 MeV. Elements found to be suited to determination by γ activation include Sb, As, Bi, Cd, Cs, Ca, Ce, Cr, Fe, Au, Pb, Mg, Mo, Ni, Nb, Rb, Sr, Tl, Ti, Tm, Zn, and Zr. γ Spectra, elemental concentrations measured, and/or limits of detection observed, for the matrices studied are given. (auth)

44 DETERMINATION OF ^{235}U IN HIGHLY ENRICHED REACTOR FUEL STICKS. Lukens, H. R.; Fleishman, D. M.; Bramblett, R. L. (Gulf Radiation Tech., San Diego, CA). J. Radioanal. Chem.; 16: No. 1, 97-104(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Measurement of uranium in highly enriched reactor fuel sticks has been achieved by elaboration of the delayed-neutron method of Amiel. Calibration of the method was achieved by three methods: comparison of dissolved sample with aqueous standard, comparison of sample with handcrafted standard stick, and the extrapolated-aliquot procedure. Precision and accuracy of <0.5% relative are ahcieved in <2 min measurement time on a production basis. Precisions of <0.1% relative are achieved in replicate measurements. (auth)

45 PRACTICAL ASPECTS OF NEUTRON ACTIVATION DETERMINATION OF THE PLATINUM METALS. Gijbels, R.; Govaerts, A. (Univ., Ghent). J. Radioanal. Chem.; 16: No. 1, 7-19(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Triple gamma coincidence counting of ^{192}Ir allowed the determination of Ir by instrumental neutron activation analysis down to 1 ppB in ultrabasic rocks and down to ca. 20 ppB in some high-furnace slags; the limiting factor for the latter matrix was the presence of ^{124}Sb. Radiochemical neutron activation analysis of the USGS standard rocks revealed that the Ir contents are up to three orders of magnitude lower than previously reported, except for the ultrabasic rocks. The factor of merit of several scintillation and semiconductor gamma detectors was determined for the neutron activation determination of Pd, Pt, and Os. In the case of radiochemically pure sources, a NaI(Tl) wafer was preferred; in the presence of high-energy gamma emitters, a Ge(Li) low-energy photon detector was superior. (auth)

46 ACTIVATION ANALYSIS OF HEAVY METALS IN SURFACE WATERS USING ION EXCHANGE FILTER PAPERS AND CYANIDE COMPLEXING. Kolaczkowski, A.; Jester, W. A. (Pennsylvania State Univ., University Park). J. Radioanal. Chem.; 16: No. 1, 21-29(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A simple, reasonably rapid, and accurate technique developed for the multielement analysis of heavy metals in surface waters using ion exchange filter papers and cyanide complexing in conjunction with neutron activation analysis is described. The method employs large water volume irradiation for improved sensitivity. ^{130}Te was used as an internal flux monitor to correct for neutron flux variations in the samples. Proof of the value of this technique was obtained by the analysis of 10 surface water samples previously analyzed using conventional methods by the U. S. Geological Survey of the U. S. Department of Interior. Good agreement resulted from this comparison. (auth)

47 RAPID DETERMINATION OF TUNGSTEN IN ROCKS USING ^{183m}W. Zinner, H.; Henkelmann, R.; Staerk, H. (Univ., Munich). J. Radioanal. Chem.; 16: No. 1, 31-38(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A rapid method was developed for the determination of tungsten, especially in rocks. The reaction $^{182}W(n,\gamma)^{183m}W$ (T = 5.3 sec) with a thermal neutron capture cross-section of 0.5 b was used. The samples were irradiated in the fast pneumatic system of the FRM, which is described briefly. The low-energy γ rays of the isomer ^{183m}W were measured by a high-resolving Ge(Li) detector. The sensitivity of the method is 0.1 mg tungsten with an accuracy of about 5%; the minimum concentration is 0.1 to 0.2% W in geological samples. The analysis time is 2 min per sample. (auth)

48 INTERFERENCES IN THE DETERMINATION OF TRACE ELEMENTS IN HIGH-PURITY TIN. Maenhaut, W.; Adams, F.; Hoste, J. (Ghent Univ.). J. Radioanal. Chem.; 16: No. 1, 39-55(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Reactor neutron activation analysis of antimony, indium, and cadmium in high-purity tin is interfered with by nuclear reactions on the tin matrix. For a number of interfering reactions the cross-sections were determined. The following results were obtained: $^{122}Sn(n,\gamma)^{123m}Sn$: σ_{th} = 0.145 barn, I = 0.79 barn; $^{112}Sn(n,\gamma)^{113}Sn$: σ_{th} = 0.52 barn, I = 25.4 barn; $^{112}Sn(n,2n)^{111}Sn$: $\bar{\sigma}_F$ = 290 microbarn; $^{116}Sn(n,\alpha)^{113}Cd$: $\bar{\sigma}_F$ = 0.252 microbarn; and $^{114}Sn(n,p)^{114m1}In$: $\bar{\sigma}_F$ = 42.3 microbarn. (auth)

49 TRACER STUDY OF A CHEMICAL SEPARATION PROCEDURE FOR THE DETERMINATION OF IMPURITIES IN SELENIUM BY MEANS OF THERMAL NEUTRON ACTIVATION ANALYSIS. Verplanke, J. C.; Kuin, P. N. (Philips Research Labs., Eindhoven, Netherlands). J. Radioanal. Chem.; 16: No. 1, 57-66(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A chemical separation procedure was developed for the determination of about 50 trace elements in high-purity selenium. The method consists of two distillation steps, followed by a precipitation step. In the first distillation step the halogens, osmium, and part of the ruthenium were volatiled; in the second the selenium is distilled together with antimony, tin, arsenic, mercury, and germanium. Selenium is precipitated from the second distillate by reduction to the element. The whole procedure has been tested by means of radioactive tracers. Interferences from the selenium

matrix with respect to the arsenic and bromine determinations are discussed. (auth)

50 DETERMINATION OF MAJOR COMPONENTS AND TRACE ELEMENTS IN ANCIENT SILVER BY THERMAL NEUTRON ACTIVATION ANALYSIS. Meyers, P. (Metropolitan Museum of Art, New York); van Zelst, L.; Sayre, E. V. J. Radioanal. Chem.; 16: No. 1, 67-78(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Thermal neutron activation of minute samples of ancient silver objects has provided useful information concerning their silver, copper, and gold content. The results of such analysis of eighteen Sasanian silver objects are discussed together with consideration of the sampling problems involved. In order to extend these measurements to include other elements, an isotopic exchange system has been developed to separate other activities present in irradiated silver specimens quantitatively from the silver, copper, and gold activities. Following exchange with cuprous and silver iodides it has been possible to count quantitatively the activity of fourteen additional elements: As, Br, Co, Cr, Fe, Hg, Ir, K, Mn, Na, Sb, Sc, Se, and Zn. (auth)

51 ACTIVATION ANALYSIS OF SUBSTANCES WITH LARGE NEUTRON-CAPTURE CROSS-SECTIONS. Alimarin, I. P.; Yakovlev, Yu. V.; Dogadkin, N. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). J. Radioanal. Chem.; 16: No. 1, 79-87(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A method was developed for the activation analysis of boron and cadmium, taking into account neutron absorption of the sample. The concept of the screening coefficient, expressing the self-screening of the matrix on the contamination is introduced. A formula is proposed for calculation of the screening coefficient, based on the boron or cadmium ratios for the contaminating elements being determined. Good agreement between experimental and calculated values was obtained. (auth)

52 DETERMINATION OF TRACES OF ^{237}Np IN URANIUM AND PLUTONIUM. Guay, P.; Pinelli, F. (CEA, Paris). J. Radioanal. Chem.; 16: No. 1, 89-95(1973). (In French).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The ^{237}Np content of ^{238}Pu or ^{239}Pu samples was determined by the gamma spectrometry of ^{233}Np formed by thermal neutron activation. The measurements were carried out on irradiated ^{238}Pu samples directly, and after the chemical separation of ^{239}Pu samples. The ^{237}Np content of natural uranium was determined from the ratio of the alpha-activities of ^{238}Pu and ^{239}Pu isotopes formed from the decay of neptunium isotopes produced by the activation of ^{237}Np and ^{238}U isotopes, respectively. (auth)

53 NEUTRON ACTIVATION DETERMINATION OF LANTHANUM IN PRASEODYMIUM OXIDE NEAR THE DETECTION LIMIT. Comparison of Various Procedures. Dybczynski, R.; Sterlinski, S.; Golian, C. (Inst. of Nuclear Research, Warsaw). J. Radioanal. Chem.; 16: No. 1, 105-114(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Trace amounts of lanthanum in spectrally pure praseodymium oxide were determined by four independent methods: (1) nondestructive Ge(Li) spectrometry, (2) spectrometry of slow $\gamma-\gamma$ coincidences, (3) radiochemical separation of ^{140}La from macro amounts of ^{143}Pr and other interfering activities (mainly ^{192,194}Ir and ^{152,154}Eu) with ~100% yield, by several ion-exchange steps followed by NaI(Tl) spectrometry, (4) method of standard additions using the same procedure as in method (3). Near the detection limit only the two last methods gave accurate results. (auth)

54 DETERMINATION OF RARE EARTHS IN YTTRIUM OXIDE BY MEANS OF A PRECONCENTRATION TECHNIQUE AND Ge(Li) GAMMA-SPECTROMETRY. Bruijs, P. C. M. N. (Philips Gloeilampenfabrieken N. V., Eindhoven, Netherlands). J. Radioanal. Chem.; 16: No. 1, 115-122(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Before predoncentration the yttrium matrix is separated from the lanthanides by means of cation- and/or anion-exchange. The rare earth elements are then concentrated by coprecipitation with 5.0 mg of iron as Fe(OH) in quartz centrifuge tubes. The dehydrated Fe-REE mixture is then irradiated and counted, without any further major manipulations, by means of Ge(Li) gamma spectrometry, the ^{59}Fe activity acting as a flux monitor and as an internal standard. (auth)

55 DETERMINATION OF RARE EARTHS IN STANDARD REFERENCE MATERIAL GLASS USING NEUTRON ACTIVATION ANALYSIS AND REVERSED-PHASE CHROMATOGRAPHY. McClendon, L. T.; LaFleur, P. D. (National Bureau of Standards, Washington, DC). J. Radioanal. Chem.; 16: No. 1, 123-126(1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Recently, the interest in quantitative determination of rare earth elements has grown considerably, especially in connection with the space programs. There has also been a need for quantitative methods for rare earth element determination in different matrices at the National Bureau of Standards. Therefore, some earlier qualitative investigations with di(2-ethylhexyl)orthophosphoric acid (HDEHP) were applied to separations of these elements for their subsequent quantitative determination. The rare earth elements in NBS Standard Reference Material 480, Trace Elements in Glass, a sodium glass to which 61 trace elements, including the thirteen naturally occurring rare earths, were added, were determined by neutron activation analysis with a chemical separation using a column (11 cm × 40 cm) of "Corvic" powder [poly(vinyl chloride-vinyl acetate)] loaded with HDEHP and operated at a constant temperature. Since earlier solvent extraction studies with HDEHP had shown perchloric acid to be the most favorable of three acids (HCl, HNO_3, $HClO_4$) for rare earth separation, the best operating conditions (e.g., time, flow, acid concentration, etc.) were established using this acid. A detailed description of the separations procedure and the quantitative results will be discussed. (auth)

56 DETERMINATION OF RARE EARTHS BY HIGH-RESOLUTION X-RAY SPECTROMETRY FOLLOWING NEUTRON ACTIVATION. Mantel, M.; Amiel, S. (Soreq Nuclear Research Center, Yavne, Israel). J. Radioanal. Chem.; 16: No. 1, 127-137 (1973).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Reactor neutron activation followed by high-resolution x-ray spectrometry has been applied to the nondestructive quantitative determination of the rare earth elements in naturally occurring materials. The various sources of error as well as the possibilities of minimizing them are discussed. (auth)

57 DETERMINATION OF COPPER IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. Akbarov, U.; Allabergenov, B. R.; Nishanov, P. Kh.; Uzakova, U.; Umirbekov, K. (Inst. of Nuclear Physics, Tashkent). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 5, 737-738(May 1973).

Translated from Zavod. Lab.; 39: No. 5, 551-552(May 1973).

Rock samples were irradiated for 30 min in a 1.8×10^{13} n/cm^2 · sec flux of thermal neutrons. To analyze the samples for copper content a radiochemical separation was made and the ^{64}Cu activity was measured with a total-coincidence spectrometer. This technique allows 30–40 analyses to be made in 6 hr, not counting the irradiation and cooling times. (LK)

58 ACTIVATION ANALYSIS OF ROCKS. Zaitsev, E. I. (Inst. of Rare-Element Mineralogy, Geochemistry, and Chemical Crystallography, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 904-908(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 678-682(Jun 1973).

The use of differential filters as a means of increasing the selectivity for characteristic and soft gamma rays from activation products is discussed. Activation analysis of rocks is used as an example. (LK)

59 NEUTRON-RADIATION ANALYSIS OF ALLOYS USING A GAMMA-RAY GERMANIUM (LITHIUM) DETECTOR. Demidov, A. M.; Ivanov, V. A.; Komkov, M. M.; Tarykchieva, N. K. (Inst. of Atomic Energy, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 947-948(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 712-714(Jun 1973).

Counting the spectra of the prompt gamma radiation emitted as a result of the capture of thermal neutrons is used as a means of analyzing the elemental composition of materials by an instrumental method. Use of this method for determining the elemental composition of alloys with the aid of a Ge(Li) detector is considered. (LK)

Chemical and Spectral Procedures

Refer also to abstracts 410 and 576.

60 (INIS-mf-972) APPLICATIONS OF CYCLIC VOLTAMMETRY IN ELECTROANALYTICAL CHEMISTRY OF SOME NUCLEAR MATERIALS. Casadio, S.; Lorenzini, L.; Orlan-

dini, F. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). Oct 1972. 8p. INIS.

From 2nd Italian-Polish meeting on some chemical, ceramic and metallurgic aspects of nuclear fuels; Rome, Italy (3 Oct 1972).

Electroanalytical investigation and both homogeneous and heterogeneous electrokinetics studies about U, Np, and Pu ions in aqueous media performed chiefly by cyclic voltammetry are reported. Application possibility of cyclic voltammetry also to the impurities (like Cu^{2+}, Cd^{2+}, Ni^{2+}, Zn^{2+}, Sn^{4+}, Bi^{4+}, Pb^{2+}, and Tl^{+}) determination in the nuclear fuel materials is outlined. (INIS)

61 (KY-653) SPECTROGRAPHIC IMPURITY DETERMINATION AFTER PARTITION CHROMATOGRAPHY OF URANIUM. Gordanier, D. E.; Winters, B. L. (Paducah Gaseous Diffusion Plant, Ky. (USA)). 28 Feb 1974. Contract W-7405-eng-26. 17p. Dep. NTIS $4.00.

An analytical method was developed for the determination of 42 trace impurities (Al, As, Ba, Be, Bi, Co, Ca, Cd, Cr, Cu, Dy, Eu, Fe, Ga, Gd, Ge, In, K, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Ru, Sb, Sm, Sn, Sr, Ta, Tc, Th, Ti, Tl, V, W, Zn, and Zr) in high-purity uranium hexafluoride using partition chromatographic separation of the uranium from the trace impurities followed by spectrochemical analysis. The method fulfills the sensitivity requirements for specification analysis of customer-furnished uranium hexafluoride delivered to the United States Atomic Energy Commission. Time saved is about 70 percent when compared to methods previously used for the same elements. (auth)

62 (LA-5429) DETERMINATION OF URANIUM AND THORIUM IN CARBON AND SILICON CARBIDE-COATED URANIUM-THORIUM CARBIDE FUEL BEADS. Hues, A. D.; Henicksman, A. L.; Ashley, W. H. (Los Alamos Scientific Lab., N. Mex. (USA)). Oct 1973. Contract W-7405-eng-36. 9p. Dep. NTIS $4.00.

A method has been developed for titrimetric determination of uranium and thorium in uranium-thorium carbide fuel particles that have been coated with pyrocarbon, silicon carbide, and again with pyrocarbon. The particle coatings are stripped by heating alternately in oxygen and chlorine gases. The residue is dissolved, and the uranium and thorium are separated by ion exchange. The thorium is determined by titrating with Versene, using xylenol orange indicator. The uranium, after the impurities are removed by electrolysis with a mercury cathode, is reduced in a Jones reductor and determined by titration with ceric sulfate, using ferroin indicator. Because of the lack of suitable standards, the reliability of the method was estimated from measurements of known quantities of uranium and thorium in prepared solutions, and also from repeated analyses of the solutions of fuel bead samples. The average recovery of thorium from nine prepared solutions was 100.14%, with a standard deviation of 0.20%. The average recovery of uranium from 12 prepared solutions was 99.94%, with a standard deviation of 0.09%. In repeated analyses of nine samples of beaded fuel particles, the relative standard deviations were 0.13% for uranium and 0.15% for thorium. (auth)

63 (RFP-Trans-154) COLUMN EXTRACTION CHROMATOGRAPHY OF INORGANIC COMPOUNDS. Stronski, I. (Institute of Nuclear Physics, Krakow (Poland)). 1970. Translation of INP-803. 20p. Dep. NTIS (U. S. Sales Only) $4.00.

Theoretical foundations and applications of column distribution chromatography with reverse phases are reviewed. Examples are given of various extraction systems such as liquid organic phosphorus derivations, high mo.ecular amines, ketones and chelate-forming compounds with electrolytes. These are taken from the latest results in the field of the partition of salts of the lanthanides, transplutonium elements, and actinides as well as uranium and its fission products and other compounds of metals and nonmetals. (auth)

64 INTERFERENCE ENCOUNTERED IN THE DETERMINATION OF THE NOBLE METALS BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Mallet, R. C.; Pearton, D. C. G.; Ring, E. J.; Steele, T. W. J. S. Afr. Chem. Inst.; 25: No. 3, 219-229 (Feb 1972).

Although there are many interferences in the determination of the noble metals by A.A.S., resulting from the presence of the noble metals themselves and, particularly, from the presence of a number of base metals, these can be overcome in most instances by the addition of releasing agents such as uranium and vanadium. Attention must also be paid to the medium in which measurements are made because this can also have a marked effect on the determination. In practice, where the concentration of base metals is above 1,000 ppM, it may be advisable for excess aqua regia to be removed before the application of the uranium-addition method in a medium of 40% hydrochloric acid. Generally, base-metal concentrations should be below 5,000 ppM when uranium is used. Uranium addition is used in the analysis of silver prills, resulting in a rapid method requiring only that the prills should be dissolved in sealed tubes with aqua regia and then diluted after the addition of the uranium. Where solutions requiring analysis contain base metals in appreciable amounts, the vanadium-addition method is used. Although the nitrous oxide-acetylene flame holds some promise as a means of removing interferences, it has not been used because in most instances maximum sensitivity is required. However, if some simple means of restoring sensitivity, for example by the addition of some de-ionizing agent, can be found, it may become a useful technique. (INIS)

65 SPECTROPHOTOMETRIC STUDY OF THE INTERACTION OF ORTHANYL B WITH RARE EARTH ELEMENTS. Kirillov, A. I.; Shaulina, L. P.; Vlasov, N. A. (Irkutsk State Univ., USSR). Zh. Anal. Khim.; 29: No. 1, 62-65(Jan 1974). (In Russian).

The complex formation of orthanyl B with rare earths was studied. La, Ce, Pr, and Nd give most sensitive color reactions while other rare earths do not give color reactions with the reagent. Optimal pH value for the complex formation is 4.0. The sensitivity of the color reactions of La, Ce, Pr, and Nd with orthanyl B and instability constants for the complexes were determined. The effect of foreign metal ions was determined. Lanthanum can be determined in a mixture with lutetium. (auth)

66 DETERMINATION OF A GADOLINIUM IMPURITY IN LANTHANUM OXIDE BY X-RAY EXCITED LUMINESCENCE. Zhikhareva, E. A.; Zelyukova, Yu. V.; Smirdova, N. I.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 29: No. 1, 76-79(Jan 1974). (In Russian).

The luminescence of Gd^{3+} ions in crystallophosphors based on lanthanum oxychloride was studied by means of a single-beam spectrofluorimeter constructed from a monochromator of a SF-4 spectrophotometer and an X-ray apparatus URS-55a. A luminescence method was developed for determining gadolinium in lanthanum oxide with the sensitivity of 2×10^{-4} % Gd. (auth)

67 APPLICATION OF DIETHYLENETRIAMINEPENTA-ACETIC ACID (DTPA) FOR THE SUBSTOICHIOMETRIC ISOLATION OF TRACE AMOUNTS OF ZIRCONIUM BY PAPER ELECTROPHORESIS. Akol'zina, L. D.; Alimarin, I. P.; Bilimovich, G. N.; Churkina, N. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 29: No. 1, 80-84(Jan 1974). (In Russian).

The substoichiometric reaction of zirconium with diethylenetriaminepenta-acetic acid (DTPA) in perchloric acid solutions was studied by the method of paper electrophoresis. A method of zirconium determination in trace amounts by isotope dilution analysis using substoichiometric amounts of DTPA with a sensitivity of 10^{-11} g in 0.01 ml and a variation coefficient of 10% was developed. (auth)

68 MASS-SPECTROMETRIC DETERMINATION OF OXYGEN AND NITROGEN IN METALS BY USING CRYOSORPTION EVACUATION OF THE IONIC SOURCE. Glinskikh, V. M.; Melashvili, V. A.; Ordzhonikidze, K. G.; Samadashvili, O. A. Zh. Anal. Khim.; 29: No. 1, 116-118(Jan 1974). (In Russian).

A suggested procedure with cryosorption evacuation of the ionic source made it possible to lower the pressure of residual gases in a spark region by two orders. As a result the intensity of oxygen and nitrogen background lines decreased so that the sensitivity of the analysis of the gases increased to about 10^{-5} wt. %. The use of the cryosorption evacuation made it possible to reduce markedly the time needed for the analysis of gas impurities. It became comparable with that needed for the analysis of metal impurities. (auth)

69 CHEMICAL ANALYSIS OF SOLID SOLUTION xHo_2O_3 $(1-x)ZrO_2$ THIN FILMS BY X-RAY FLUORESCENCE. Darashkevich, V. R.; Malyukov, B. A. Zh. Anal. Khim.; 29: No. 1, 119-124 (Jan 1974). (In Russian).

An x-ray fluorescence analysis method to control composition and thickness in solid solutions of $xHo_2O_3 \cdot (1-x)ZrO_2$ thin films is described. Ho_2O_3 and ZrO_2 thin films produced by thermal sputtering and electron beam heating were used as standards. Approximate expressions to calculate surface density of Ho_2O_3 and ZrO_2 film specimen which take into account x-ray absorption effect were developed. (auth)

70 QUATERNARY AMMONIUM BASES AS ANALYTICAL REAGENTS. Part 4. Use of N-Benzylquinolinium Chloride for Determination of Zirconium. Kostrova, A. M.; Markov, G. S.;

Posvol'skii, M. V. (Radium Inst., Leningrad). Zh. Anal. Khim.; 29: No. 1, 157-158(Jan 1974). (In Russian).

A gravimetric method is suggested for determination of zirconium based on its precipitation with N-benzylquinolinium chloride from 10−11.5 M HCl solution as $(C_{16}H_{14}N)_2[ZrCl_6]$. (auth)

71 CHROMATOGRAPHIC SEPARATION OF URANYL IONS FROM ACCOMPANYING ELEMENTS. Eristavi, V. D.; Kutsiava, N. A.; Kekeliya, R. A. (Polytechnic Inst., Tbilisi, USSR). Zh. Anal. Khim.; 29: No. 1, 158-161(Jan 1974). (In Russian).

A method was developed for chromatographic separation of uranyl ions from accompanying elements including its sorption on the AV-17 anion exchanger in the CO_3^{2-}-form followed by step elution. The relative error of the photometric method of determining uranyl ions with arsenazo III after its chromatographic separation is not more than 5.5%. (auth)

72 ISOTOPIC SPECTRAL ANALYSIS OF MICROQUANTITIES OF OXYGEN BY USE OF HIGH-FREQUENCY DISCHARGE. Muchkaev, A. A.; Nemets, V. M.; Petrov, A. A.; Skvortsova, G. V. Zh. Prikl. Spektrosk.; 19: No. 6, 879-982(Dec 1973). (In Russian).

During the spectral isotopic analysis of small quantities of oxygen by the emission bands of CO a change is observed in the times of relative luminesce of the component of the isotopic structure $^{16}I/^{18}I$ caused by the parasitic isotopic exchange of the oxygen of the sample with the oxygen occurring on the walls of the quartz discharge tube. The relation $^{16}I/^{18}I = f(t)$ is determined by the quantity of sample to be analyzed and by its compression pressure in the discharge tube. It is possible to reduce the magnitude of error and to increase its absolute sensitivity by means of graphic extrapolation of the relation $^{16}I/^{18}I = f(t)$ at the moment $t = 0$. It is obvious that in this case the distortion of the ratio $^{16}I/^{18}I$ is at a minimum. It is established that for such quantities of the sample there is a minimum permissible compression pressure at which extrapolation errors do not exceed 2 to 3%. The method developed is used to reduce the quantity of sample in the analysis down to ~0,002 cm^3 under normal conditions. During calculations of $^{16}I/^{18}I$ the transposition of the ^{16}CO and ^{18}CO bands is taken into consideration. (tr-auth)

73 DETERMINATION OF MICROAMOUNTS OF URANIUM IN CARBONATE ROCKS. Iskanderova, A. D.; Levchenkov, O. A. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 266-268(1973).

Translated from Radiokhimiya; 15: No. 2, 268-270(1973).

Methods of isolating and determining microamounts of uranium were studied. Ion-exchange resins were used to isolate uranium in uranium-containing rocks for determination by colorimetry. Results from this method and the isotope dilution technique were compared. The latter method is more accurate due to the incompleteness of isolation of uranium by the resin. For a uranium content of $n \cdot 10^{-4}$% the colorimetric values were no more than 5% low; for a uranium content of $n \cdot 10^{-5}$% they were 10-15% low. (LK)

74 COMPLEXOMETRIC ANALYSIS OF MAGNETIC ALLOYS. Zhukova, L. V.; Lumpova, M. I.; Shvarev, V. S.; Kirsanova, L. I. Ind. Lab. (USSR) (Engl. Transl.); 39: No. 5, 841-842(May 1973).

Translated from Zavod. Lab.; 39: No. 5, 631(May 1973).

Complexometric methods for determining base components in Co−Sm, Co−Sm−Fe, Co−Sm−Ni, and Co−Sm−Cu magnetic alloys are described. A 1-g sample of the alloy is dissolved by heating in a mixture of hydrochloric and nitric acids. A 0.05 M solution of complexone III is used in the titration. (LK)

75 METHOD OF DETERMINATION OF HYDROGEN IN CERIUM HYDRIDE (EXCHANGE OF EXPERIENCE). Karabash, A. G.; Elovatskaya, A. I. Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 897(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 674-675(Jun 1973).

Cerium hydride decomposes actively at temperatures above 1100°C. In the proposed method, the temperature of the decomposition of cerium hydride was lowered to 640°−680°C by the use of a flux-metallic tin. The relative error of the method is about 0.6%. (LK)

76 DETERMINATION OF NANOGRAM QUANTITIES OF EUROPIUM BY LUMINESCENCE (EXCHANGE OF EXPERIENCE). Tishchenko, M. A.; Zheltvai, I. I.; Poluektov, N. S.; Bakshun, I. V. (Inst. of General and Inorganic Chemistry, Odessa). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 890(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 671(Jun 1973).

Small quantities of europium can be determined by the luminescence of a suspended precipitate of a mixed ligand complex with dibenzoylmethane and diethylamine. The sensitivity of the method was $3 \cdot 10^{-6}$% of Eu_2O_3 in the oxides of lanthanum, gadolinium, lutetium, and yttrium. (LK)

77 USE IN ANALYSIS OF THE LUMINESCENCE OF A COMPLEX OF THE TERBIUM ION WITH ACETYLACETONE AND EDTA (EXCHANGE OF EXPERIENCE). Tishchenko, M. A.; Zheltvai, I. I.; Poleuktov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 888-889(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 670-671(Jun 1973).

The results of an investigation of the suitability for analytical purposes of the luminescence from a mixed complex of terbium with EDTA and acetylacetone are reported. The sensitivity of the method was $2 \cdot 10^{-4}$% of Tb_4O_7. One advantage of this method is the stability of the terbium complex in solution. (LK)

78 DETERMINATION OF FLUORINE IN Y(III) AND Ce(III, IV) FLUORIDES BY A CARBONATE METHOD. Kiselev, Yu. M.; Martynenko, L. I. (Moscow State Univ.). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 876-877(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 662-663(Jun 1973).

A method based on the passage of fluorine from the fluoride precipitate into the solution of a fluorocarbonate complex, which is stable in acid solutions (pH 1−3), followed by the determination of fluorine by titration with thorium nitrate is described. (LK)

79 USE OF ORGANIC SULFUR-CONTAINING COMPOUNDS IN AMPEROMETRIC TITRATION (SURVEY). Songina, O. A.; Bessarabova, I. M. Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 851-866(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 641-655(Jun 1973).

The use of organic reagents containing thione and thiol groups of atoms in analytical chemistry is reviewed. A table of amperometric determinations using these organic reagents is included. (178 references) (LK)

80 METHOD OF THE FLUOROMETRIC DETERMINATION OF SCANDIUM IN RARE EARTH OXIDES WITH THE β-HYDROXYNAPTHALHYDRAZIDE OF ANISIC ACID. Dolgorev, A. V.; Pavlova, N. N.; Ershova, V. A. (Inst of Mineralogy, Geochemistry, and Crystallochemistry of Rare Elements, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 870-872(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 658-660(Jun 1973).

A fluorometric method using hydrazo III is described for determining more than $3 \cdot 10^{-4}$% scandium in rare-earth oxides.

81 MICROPROBE AS AN ANALYTICAL INSTRUMENT FOR STUDYING SPENT NUCLEAR FUELS. Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). KFK Nachr.; 5: No. 3, 1-6(Nov 1973). (In German).

After a brief historical review of the development of electron probe microanalysis and the description of its practical fundamentals, its application to the determination of U/Pu-concentration profiles in irradiated mixed nuclear fuel is reported. In this context, the criteria of the efficiency of an electron probe as well as the particular problems involved in the analysis of irradiated materials are considered. Two examples, the determination of radial distribution of U/Pu-concentration of a fuel rod and the x-ray specific scanning pattern images of the canning, show the importance of electron-microprobe studies as a useful tool for the clarification of segregation processes in the nuclear fuel and the migration of fission products in the fuel can. (GE)

82 METHODS FOR THE QUANTITATIVE ESTIMATION OF NANOGRAM AND SUBNANOGRAM AMOUNTS OF STEROIDS IN BLOOD AND URINE. Petrak, K. (Univ. of Sussex, Eng.). CRC Crit. Rev. Anal. Chem.; 3: No. 4, 421-453(Jan 1974).

A vast number of methods exist for quantitative determination of steroids in biological samples. It is difficult to recommend a single method that should be used for a particular study. Spectrophotometric techniques, although relatively simple, may occasionally lack detection sensitivity. The basically nonspecific gas-liquid chromatographic techniques, though very sensitive, may require excessive time for analysis and relatively expansive equipment and are thus often felt to be impracticable. The latest advances in the combined gas liquid chromatographic-mass spectrometric technique make the sensitivity of the technique comparable to radioimmunoassays while retaining the unique specificity of mass spectrometric detection. At present, however, this technique is not yet sufficiently developed for use in routine work, and the equipment needed is very expensive. Double-isotope derivative assays are very laborious, frequently involving up to five or six chromatographic purification steps. Methods based on protein binding are relatively simple, can be made highly specific, and are highly sensitive. It seems that competitive protein binding and radioimmunoassays will find more and more use for

steroid hormone assays in clinical practice. The limit of detection is of vital importance in evaluating the suitability of a technique for quantitative determinations at the nanogram level. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 363, 365, 422, and 721.

83 (AD-763728) ENERGY-DISPERSIVE ANALYSIS OF X RAYS PRODUCED BY RADIOACTIVE SOURCES. Swick, W. A. III. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio (USA). School of Engineering). Mar 1973. 76p. (GEP/PH-73-22). NTIS $6.00.

Thesis.

A system for energy-dispersive analysis of x rays produced by radioactive sources was evaluated in the study. ^{55}Fe, ^{109}Cd, and ^{241}Am were used to produce fluorescent characteristic x rays in a variety of samples. Methods of reducing matrix effects were investigated. Dilution techniques were used to eliminate matrix effects for concentrations below 0.001g/square cm. Dilute solutions of metal salts were evaporated to deposit samples of 10^{-4} to 0.01 g which were irradiated to produce net count rate of K x rays vs weight curves for different elements. Samples of unknown composition were examined and the weights of the elements present in these samples were determined from the net count rate curves. Samples of atmospheric dust were found to contain elements such as zinc, gallium, bromine, lead, calcium, and strontium in microgram quantities. (GRA)

84 (CEA-N-1685) MEASUREMENT OF NATURAL CONCENTRATIONS OF TRITIUM PRESENT IN SMALL QUANTITIES OF WATER. Jouzel, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91-Gif-sur-Yvette (France). Dept. de Recherche et Analyse). Jan 1974. 75p. (In French). Dep. NTIS (U. S. Sales Only) $6.75.

Measurements of the tritium contents of small water samples (having masses of less than 500 mg and count rates generally not exceeding 0.2 counts per minute) were optimized in view of determining the distribution of tritium in hailstones. An OESCHGER type proportional counter with a volume of 2.5 liters was used; this counter enabled a very small blank value to be obtained. The water is reduced on magnesium and the hydrogen produced reacts on tritium free ethylene to form ethane which is used as the counting gas. Under the filling pressure of 233 torr, the counting value obtained for a sample prepared from tritium free water is 0.18 counts per minute. This performance enables 20 UT to be detected (1 UT corresponds to a T/H ratio = 10^{-18}) for a 0.2 g mass of water. These studies also led to improvements in the precision to which tritium can be determined in water samples available in unlimited quantities. (FR)

85 (NIM-1611) X-RAY-FLUORESCENCE DETERMINATION OF PERCENTAGE CONCENTRATIONS OF NIOBIUM AND TANTALUM IN ORES AND MINERALS. Eddy, B. T.; Austen, C. E.; Russell, B. G. (National Inst. for Metallurgy, Johannesburg (South Africa)). 25 Jan 1974. 17p. Dep. NTIS (U. S. Sales Only) $4.00.

Investigational work in the development of a procedure for the determination of tantalum and niobium in ores where the concentration of either element exceeds 0.5% is described. The samples are decomposed by the use of a flux that incorporates two internal standards, and the technique obviates the need for the determination of the backgrounds and corrects for matrix effects. Calibration is achieved by means of synthetic standards. The precision of the method compares well with chemical methods, and the time required is much less. (auth)

86 (UCD-472-119, pp 101-105) PARAMETERS AFFECTING CHERENKOV COUNTING OF BIOLOGICAL SAMPLES. Parks, N. J.; Abrahams, C. D. Jun 1972.

In annual report, fiscal year 1972.

The effects of variations in sample optical density and instrument parameters on radioactivity assays of wet-ashed tissues by Cherenkov counting are evaluated. (auth)

87 RADIOISOTOPE METHOD OF SIMULTANEOUSLY DETERMINING TANTALUM, NIOBIUM, AND CERTAIN ACCOMPANYING ELEMENTS. Anosov, V. V.; Sobinyakova, N. M.; Gavrilov, N. I. (All-Union Scientific-Research Inst. of Raw Minerals, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 5, 733-736(May 1973).

Translated from Zavod. Lab.; 39: No. 5, 548-551(May 1973).

A method of analyzing three components in ores by means of radioactive isotopes is described. This method is based on the difference in the spectral composition of the gamma radiation arising from the radioactive isotopes used. During the processing of tantalum-niobium ores, tantalum, niobium, and titanium or tantalum, niobium, and iron are determined. In the processing of niobium ores, niobium, titanium, and iron are determined. The radioisotopes used were ^{182}Ta, ^{95}Nb, ^{44}Ti, and ^{59}Fe. (LK)

88 X-RAY FLUORESCENT ANALYSIS OF SMALL AMOUNTS OF A MATERIAL. Makov, V. M.; Pavlinskii, G. V.; Lebed, V. I.; Losev, N. F. (Inst. of Geochemistry, Novosobirsk, USSR). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 926-929(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 696-699(Jun 1973).

The possibility of analyzing "unsaturated" radiators by using the relationship between the intensity of the analyzed radiation and the concentration of the determined element that is correct for "thin" radiators is discussed. A method was developed for determining the content of niobium in small amounts of analyzed material. A sample preparation method was developed that provides strong and sufficiently uniform specimens having surface densities constant over the entire specimen area. (LK)

89 ANALYSIS BY X-RAY ABSORPTION WITH A TWO-ENERGY SINGLE BEAM. Voronov, B. V.; Koltunov, B. G.; Kokhov, E. D. Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 909-911(Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 682-684(Jun 1973).

Interference from elements with similar atomic numbers is experienced in the analysis of some elements by x-ray absorption, because for these elements the characteristic Kα lines lie on different sides of an absorption edge for the atomic number Z of the target. X-ray spectra and absorption edges for 27 elements, including the rare earths, are given in the range 28 to 84 keV. Methods are described for the determination of iodine in solution and tungsten in solution. Radiation from the target alone is used; isolation of the characteristic $K\alpha_1$ and $K\alpha_2$ lines is accomplished by filters, one of which consists of the target element. In the case of tungsten, two pairs of filters were used, and the effects of impurities were negligible. (JGB)

Separation Procedures

Refer also to abstract 693.

90 (CONF-740311-2) SEPARATION OF TRACE RADIONUCLIDES BY ION EXCHANGE IN THE PRESENCE OF OTHER COMPETING IONS. Lin, K. H. (Oak Ridge National Lab., Tenn. (USA)). [nd]. 44p. Dep. NTIS $4.25.

From American Institute of Chemical Engineers national meeting; Tulsa, Oklahoma, USA (10 Mar 1974).

The performance of larger-than-bench-scale ion-exchange systems is evaluated using solutions containing trace amounts of ^{137}Cs, ^{85}Sr, and ^{131}I, and large amounts of either NaCl or Na_2HPO_4, H_3BO_3, and LiOH. The breakthrough behavior of trace radionuclides was influenced by excess ionic species, but remained consistent with empirical rules of selectivity. (auth)

91 (IS-T-610) SCALE-UP OF A MIXER-SETTLER EXTRACTOR USING A UNIT OPERATIONS APPROACH. Lindholm, D. C. (Ames Lab., Iowa (USA)). Apr 1974. Contract W-7405-eng-82. 94p. Dep. NTIS $7.75.

Thesis.

The results of scale-up studies on a continuous, multistage horizontal mixer settler extractor are presented. The chemical system involves the separation of lanthanum from a mixture of rare-earth chlorides using di(2-ethylhexyl)phosphoric acid as the solvent and dilute HCl as a scrub solution in a bench-scale extractor having a hold up of 2.6 liters per stage. A single stage unit is utilized for scale-up studies. Results are obtained on four sizes of geometrically similar units, the largest being six times the volume of the original bench size. A unit operations technique is chosen so that mixing and settling can be examined independently. Variables examined include type of continuous phase, flow rate of inlet streams, and power input to the mixer. Inlet flow rate ratios are kept constant for all tests. Two potential methods of pump-mixer scale-up are explored; the maintenance of constant impeller tip speed and constant power input. For the settler the previously successful method of basing design on constant flow per unit cross sectional area is used. (auth)

92 (JINR-E12-7744) RAPID ELECTRODEPOSITION OF RADIOACTIVE RARE EARTH. Beyer, G. J.; Herrmann, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 12p. Dep. NTIS (U. S. Sales Only) $4.00.

A method is described for electrodepositing carrier-free radioactive rare-earth nuclides onto a small tungsten cathode. The nuclides are deposited to more than 80% in 30 to 40 sec. The whole operating time including an evaporation step is about 2 min. (auth)

93 DESORPTION OF IODINE FROM AN EXCHANGER BY A SOLUTION CONTAINING SOME IODINE. Kazakov, E. V.; Kotov, S. D.; Ovchinnikova, N. A. (Pedagogic Inst., Simferopol, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 47: No. 7, 980-981 (Jul 1973).

Translated from Zh. Fiz. Khim.; 47: No. 7, 1733-1735(Jul 1973).

The liquid desorption of iodine from an exchanger can be effected by solutions containing iodine (e.g., natural mineral brines and seawater). Equations are suggested for finding the true concentrations of iodine on the exchanger during desorption and for determining the quantity of desorbing solution. (auth)

94 ISOLATION OF MICROADMIXTURES FROM SUSPENSIONS OF NEODYMIUM OXALATE BY ELECTRODIALYSIS. Khaeva, L. Kh.; Zarinskii, V. A.; Ryabukhin, V. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 29: No. 1, 66-70(Jan 1974). (In Russian).

The isolation of labeled Fe, Co, Zn, Cu and Ca microadmixtures from suspensions of neodymium oxalate as a function on $H_2C_2O_4$ concentration was investigated. At a 10^{-2} to 10^{-4} % content the admixtures were isolated with a yield of >90% into the concentrate, which makes it possible to increase the sensitivity of their spectral determination by 1 to 1.5 order. The kinetics of microadmixture isolation from suspensions were investigated. It proceeds in two stages which reflect the surface and volumetric capture of microadmixtures by particles of the suspension. At the first stage the isolation degree depends exponentially on time. (auth)

95 IODINE SORPTION PROCESS OF N-, O-, AND S-CONTAINING SORBENTS. Korshak, V. V.; Zubakova, L. B.; Nikiforova, L. Ya.; Kachurina, N. V. (Moscow Inst. of Chemistry and Tech.). Tr. Mosk. Khim.-Tekhnol. Inst.; No. 70, 201-204(1972). (In Russian).

Complex-forming sorbents prepared on a vinylpyridine, vinylpyrrolidone, and vinylthiopyrrolidone base were studied for iodine extraction. The following sorbents were selected: poly-2-methyl-5-vinylpyridine (2,5-MVP), copolymer of 2-methyl-5-vinylpyridine with triethylenglycoldimetacrylate (MVP-3), copolymer of N-vinylpyrrolidone with triethylenglycoldimetacrylate (PVP-3), and poly-N-vinylthiopyrrolidone (TP) with different contents of S (7.6 and 17.8%). The determination of the absorption capacity was carried out under static conditions from 0.1N solutions of I_2 in KI. The greatest absorptive capacity for iodine was shown by polyvinylthiopyrrolidone (14.3 to 16.8 mg-equiv./g) containing S atoms with very clearly shown electrodonor properties in comparison with atoms of O and N; with increase of the S content the iodine capacity increases. The quantity of absorbed iodine changes with the variation of the ratio of the sorbent, expressed in base-mole of sorbent, to g-mol of the iodine. The greatest capacity of TP for iodine was obtained at a ration TP:I_2 = 1:6.5. With further increase of iodine with respect to TP the capacity is increased significantly. The mechanism of the sorption of iodine by polyvinylthiopyrrolidone and polyvinylpyrroliodine was studied. (tr-auth)

96 HYDROMETALLURGICAL PROCESSING OF Mo-Bi PRODUCTS. Glazkov, E. N.; Ovintseva, S. A.; Radchenko, V. P. Tsvetn. Metal.; No. 5, 26-29(May 1973). (In Russian).

A method was developed for the extraction of Bi (93 to 94%) from sulfide Mo-Bi products. After leaching out of the Bi the filter cakes are treated to flotation enrichment. A product containing 22 to 25% Mo with extraction of 98 to 99% was obtained. (tr-auth)

97 PREPARATION OF HIGH PURITY MOLYBDENUM FROM MOLYBDIC SOLUTIONS USING ION EXCHANGE. Lorang, G.; Langeron, J. P.; Vu Quang Kinh. (CNRS, Vitry-sur-Seine, France). Ann. Mines; No. 4, 239-250(Jul 1973). (In French).

Studies of the fixing of Mo, W, et Ta by ion exchange resins in hydrochloric media demonstrated the role played by hydrogen peroxide. This reagent leads to the production of Mo(VI), W(VI), and Ta(V) peroxide complexes and avoids their hydrolysis in weakly concentrated hydrochloric media. The combined presence of hydrogen peroxide and molybdenum salts considerably enhances the fixing of W impurities on Dowex 1 × 8 resin. The desorption of the tungsten peroxide complexes is effected using a pure 4N HCl solution. In contrast, no significant modifications are observed in the absorption behavior of the following elements: Co, Cr, Cu, Fe and Zn. Research on eluting agents for Mo demonstrated the necessity of using an ammonium salt solution (nitrate or perchlorate) and ammonium hydroxide. The desorption mechanism for molybdic species involving oxidation-reduction reactions between Mo(V) and Mo(VI) is outlined. A very high purification method for Mo salts in hydrochloric media was developed which eliminates most of the impurities and especially W. The refined solution is evaporated to dryness and the product obtained is reduced by hydrogen at 1000°C. In this way, the concentrations of most of the elements present in molybdenum are reduced to less than 10^{-4}. (FR)

98 CONCENTRATION OF ^{35}S BY THE FOAM FORMATION METHOD USING ALKYLTRIMETHYLAMMONIUM CHLORIDE. Evtyukhova, O. V.; Nikiforov, A. F.; Berezyuk, V. G Pushkarev, V. V.; Basov, A. S. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 269-272(1973).

Translated from Radiokhimiya; 15: No. 2, 271-274(1973).

A study was made of the extraction of microamounts of ^{35}S from aqueous solutions using alkyltrimethylammonium chloride as the foam former. It was established that the entrainment of the radioisotope ^{35}S into the foam layer is independent of the extraction of the detergent itself, but is determined only by the presence and the concentration in solution of competing additives. (auth)

99 EXTRACTION OF BERYLLIUM WITH 1-PHENYL-3-METHYL-4-BENZOYLPYRAZOLONE-5 AND ACETOACETIC ESTER. Sevast'yanov, A. I.; Lanskaya, N. G.; Rudenko, N. P. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 260-262(1973).

Translated from Radiokhimiya; 15: No. 2, 263-265(1973).

The kinetics of extraction of beryllium by solutions of PMBP (1-phenyl-3-methyl-4-benzoylpyrazolone) and AAE (acetoacetic ester) in various solvents were elucidated. A study was made of the extraction of beryllium with solutions of PMBP and AAE in CCl_4, $CHCl_3$, C_6H_6, C_6H_{12}, and iso-$C_5H_{11}OH$ at μ = 1.0. The conditions were determined for extraction of tracer amounts of beryllium from lithium chloride solution (1-11 M) by means of solutions of PMBP and AAE in CCl_4, C_6H_{12}, $CHCl_3$ C_6H_6. (auth)

100 EXTRACTION SEPARATION OF CALCIUM FROM SCANDIUM. Gorbenko, F. P.; Lapiskaya, E. V.; Loshkareva, N. I. Sov. Radiochem. (Engl Transl.); 15: No. 2, 258-259(1973).

Translated from Radiokhimiya; 15: No. 2, 261-262(1973).

An extraction method is proposed for separating calcium and scandium by means of the extractant AT (a solution of azo-azoxy-BN). The calcium is extracted from 0.5 N NaOH solution in the presence of potassium sodium tartrate. The method may be used to free radioactive calcium from scandium. (auth)

101 KINETICS OF EXTRACTION OF NITROSORUTHENIUM FROM NITRIC ACID SOLUTIONS BY TRI-N-BUTYL PHOSPHATE WITH MIXING OF THE LIQUIDS IN A CENTRIFUGAL FIELD. Pushlenkov, M. F.; Shchepstil'nikov, N. N.; Kuznetsov, G. I.; Kasimov, F. D.; Yasnovitskaya, A. L.; Yakovlev, G. N. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 252-254(1973).

Translated from Radiokhimiya; 15: No. 2, 256-258(1973).

In the study of the kinetics of the extraction of nitrosoruthenium in the system HNO_3 – 1.1 μ TBP in CCl_4 in a centrifugal extractor it was shown that the presence in the nitric acid solution of chemical forms of ruthenium with different extraction properties is responsible for the two-stage nature of the processes studied. The first stage is a fast diffusion stage, which is complete in 0.6 sec. The second stage is a slow chemical stage, which does not reach equilibrium in 1 hr, and its duration is dependent on the HNO_3 concentration and independent of stirring rate. (LK)

102 EXTRACTION OF NITRIC ACID, PLUTONIUM(IV), URANIUM(VI), ZIRCONIUM, AND RUTHENIUM(III) NITROSONITRATE FROM NITRIC ACID SOLUTIONS BY MEANS OF LONG-CHAIN ALIPHATIC ALCOHOLS. Mezhov, E. A.; Shmidt, V. S. Sov Radiochem. (Engl. Transl.); 15: No. 2, 250-251(1973).

Translated from Radiokhimiya; 15: No. 2, 254-255(1973).

The extraction properties of various long-chain aliphatic alcohols were compared on the example of their extraction of nitric acid, plutonium (IV), uranium (VI), and zirconium nitrates, and ruthenium (III) nitrosonitrate from nitric acid solutions. It was shown that the elements listed and nitric acid are extracted appreciably by these alcohols with high acidity of the aqueous phase. With an increase in the length of the hydrocarbon chain in the alcohol molecules, their extraction power falls. (auth)

103 ADSORPTION OF CESIUM VAPOR BY CARBON SORBENTS. Trofimov, A. M.; Smirnov, V. A.; Tetervin, G. K. Sov Radiochem. (Engl. Transl.); 15: No. 2, 233-236(1973).

Translated from Radiokhimiya; 15: No. 2, 241-244(1973).

Sorptive properties of activated carbons produced in the Soviet Union in their reaction with cesium vapors were studied. Isotherms under static conditions were determined. Over the pressure range 1.5×10^5 to 10^{-2} mm Hg the experimental points of the isotherm lie satisfactorily on straight lines, corresponding to an adsorption process described by the parabolic equation of Freundlich $a = \alpha P^{\mu}$, where a is the amount of adsorption, α and μ are coefficients, and P is the equilibrium vapor pressure of cesium. With an increase in the temperature of the sample the amount of adsorption changes somewhat over the whole pressure range and the maximum amount of cesium adsorbed falls from 1.30 g/g at T = 573°C to 1.02 g/g at T = 773°C. (MCG)

Inorganic, Organic, and Physical Chemistry

Chemical and Physicochemical Properties

Refer also to abstracts 203, 209, and 2281.

104 HYDROTHERMAL REDUCTION OF MOLYBDATE SOLUTIONS WITH SUCROSE. Derry, R.; Milling, J. (Dept. of Trade and Industry, Stevenage, Eng.). Aust. Chem. Eng.; 14: No. 11, 17-22(Nov 1973).

Molybdenum dioxide was precipitated from ammonium and sodium molybdate solutions by hydrothermal reduction with sucrose. No catalyst was required to initiate the reaction. The yields increased as the initial pH of the molybdate solutions was lowered and high yields were obtained at 250°C if an excess over the stoichiometric amount of sucrose was used. Potential-pH diagrams at 25 and 250°C for the Mo–H_2O system are presented. (auth)

105 STUDY OF SAMARIUM BEHAVIOR UNDER CONDITIONS OF CLASSICAL POLAROGRAPHY. Kopanskaya, L. S.; Mirovich, L. V.; Do Nqok Khue. (Inst. of Chemistry, Kishinev, USSR). Zh. Anal. Khim.; 29: No. 1, 71-75(Jan 1974). (In Russian).

It was shown by the method of classical polarography that the reduction of Sm(III) in 0.25 M LiCl solution at pH 3 is a complex process. At first stage the reduction is controlled by diffusion, the electrode process is reversible and corresponds to the reduction of Sm(III) to Sm(II). Two possible schemes are suggested to account for the nature of the second wave. The reduction proceeds with the participation of foreign H^+ ions that leads to the maximum formation. The second wave is conditioned by two processes: an electrochemical one and a chemical one of the formation of basic salts or hydroxides. (auth)

106 SEMI-INDUSTRIAL TEST OF SORPTION EXTRACTION OF W FROM HCl SOLUTIONS. Kholmogorov, A. G.; Tynyanaya, G. G.; Kevrukh, A. P. Tsvetn. Metal.; No. 5, 56-60(May 1973). (In Russian).

The anionites AV-17 × 8P and AV-17 × 10P with microporous structure (bulk density of 0.44 to 0.47 g/cm^3 and specific surface of 23.9 and 42.8 m^2/g) were used for the extraction. The maximum permissible volume capacity of the anionites with respect to WO_3 is 35.5 to 39.7% and up to overshoots of the volume capacity of 14.5 to 19.6% and depends on salt composition of the solution. A flow chart was given for the ion exchange extraction. (tr-auth)

107 ELECTROSTATIC INTERACTION BETWEEN THE ETHIDIUM ION AND POLYANIONS OF VARIABLE CHARGE DENSITY. Domard, M. (Univ., Grenoble, France); Rinaldi, R.; Rinaudo, M. J. Chim. Phys.; 70: No. 10, 1410-1416(Oct 1973). (In French).

The formation of an electrostatic complex between a locally rigid polyanions (carboxymethylcelluloses having variable charge densities) and the ethidium ion was studied in order to elucidate chemical radioprotection mechanisms. The preparation of an ethidium hydroxide solution having well defined properties enables external electrolytes to be eliminated together with competitive secondary effects. Measurements of the fluorescence level enabled the level of strong fixing on the different sites to be deduced. It is shown that this level is directly related to the polyion charge parameter. The technique proposed also leads to the determination of the ion selectivity of ionizable sites. (FR)

108 DIFFUSION OF GASES AT HIGH PRESSURES. 4. Diffusion of CTH_3 in the $^{12}CO_2$–CH_4 System. Takahashi, S. (Tohoku Univ., Sendai). Tohoku Daigaku Hisuiyoeki Kagaku Kenkyusho Hokoku; 22: No. 2, 163-173(Dec 1972). (In Japanese).

The diffusion coefficients of radioactive methane (CTH_3) in normal methane, in carbon dioxide, and in a mixture of normal methane with carbon dioxide (0.522 mol fraction of methane) were measured at 25, 50, and 75°C in the 15 to 250 atm pressure range. The measurements were made through a plug of porous bronze in the diffusion cell, using a radioactive tracer technique. The diffusion coefficient-density products, Dρ, for the CTH_3–normal methane system and the CTH_3–binary mixture system increased slightly with an increase in the density in the lower-density region at 25 and 50°C, but they were nearly constant at 75°C. The Dρ for the CTH_3–carbon dioxide system decreased with an increase in the density at each temperature. The Dρ-values at 1 atm obtained by extrapolation agreed fairly well with those reported in the literature. The density dependence of the Dρ-values at high densities could not be predicted by Enskog-Thorne's theory. (auth)

109 STUDY OF COMPLEX FORMATION OF RUTHENIUM(IV) WITH FULVIC ACIDS BY THE KINETIC METHOD. Koshcheeva, I. Ya.; Varshal, G. M.; Morozova, R. P.; Velyukhanova, T. K. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 173-176 (1973).

Translated from Radiokhimiya; 15: No. 2, 177-180(1973).

The complex formation of submicrogram amounts of ruthenium(IV) with fulvic acids was studied to learn about the behavior of fission product ruthenium. The oxidation of benzidine by hydrogen peroxide at a pH of about 5 in the presence of less than 0.05 μg/ml ruthenium(IV) is characterized by an induction period that is inversely proportional to the ruthenium concentration. With a constant ruthenium concentration the induction period of the indicator reaction in the presence of fulvic acids increases with an increase in the concentration of the fulvic acids. From data on the effect of fulvic acids on the catalytic activity of ruthenium, the conventional equilibrium constant for the reaction of ruthenium(IV) with fulvic acids was calculated. (auth)

110 PHOTO-OXIDATION OF IODOMETHANE IN SOLID ARGON. Ogilvie, J. F.; Salares, V. R.; Newlands, M. J. (Memorial Univ. of Newfoundland, St. John's). (1973). vp.

From 11th international symposium on free radicals; Berchtesgaden, Germany (4 Sep 1973).

Photodecomposition of iodomethane in the presence of oxygen, both as small mole fractions in solid argon near 10°K, resulted in formation of methanal, hydrogen hypoiodite, carbon dioxide, carbon monoxide and water as major products, ozone, methanoic acid, hydroperoxyl radicals, methane and a few incompletely identified species as minor products. Extensive use of isotopic labeling, in combination with vibrational absorption spectrometry, was made to prove the identity of reaction products. The process of formation of hydrogen hypoiodite, previously undetected, is discussed, as well as possible mechanisms for other primary and secondary photochemical and subsequent reactions. (GE)

Isotope Effects

Refer also to abstracts 149, 186, and 757.

111 ERROR IN THE CALCULATION OF THE β-FACTOR FOR ISOTOPE EFFECTS IN THE HARMONIC APPROXIMATION USING OBSERVED FREQUENCIES. Ivlev, A. A. Russ. J. Phys. Chem. (Engl. Transl.); 47: No. 7, 1029-1031(Jul 1973).

Translated from Zh. Fiz. Khim. 47: No. 7, 1832-1836(Jul 1973).

The error in the calculation of the β-factor, arising when the fundamental frequencies are substituted in the harmonic approximation formula, was examined. Expressions were obtained whereby account can be taken of the error and the latter was analyzed. (auth)

112 STUDY OF METASTABLE IONS IN THE MASS SPECTRA OF DEUTERATED ETHYLENES. Baumel, L.; Hagemann, R.; Botter, R. (CEN de Saclay, Gif-sur-Yvette, France). pp 393-403 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973). (In French).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The intensities of the metastable ions have been determined at 50 eV for all deuterated compounds of ethylene. A very important isotope effect has been observed for the loss of molecular hydrogen from the parent ion. This reaction takes place in every case without liberation of excess kinetic energy. Comparison of our results with those obtained for CH_2-CD_2 shows that loss of a hydrogen molecule from $C_2H_4^+$ takes place in every case if the ion is either the parent or fragment and if the structure of ethylene is conserved for $C_2H_4^+$ at least at low energy. (tr-auth)

113 FRANCK–CONDON FACTORS OF THE $T_1 \rightarrow S_0$ RADIATIVE AND NONRADIATIVE TRANSITIONS OF NAPHTHALENE-h_8 AND -d_8. A Correlation Function Analysis. Stanford, A. L.; Fischer, S. F. (Northwestern Univ., Evanston, IL). Chem. Phys. (Amsterdam); 1: No. 2, 99-111(1973).

Franck–Condon factors for the $T_1 \rightarrow S_0$ transition in naphthalene-h_8 and naphthalene-d_8 are calculated employing the correlation function approach which allows us to investigate the distribution of the released electronic energy among the normal modes of the final ground state. The relevant coupling parameters relating to geometry, frequency and anharmonicity changes due to excitation are included. Those related to geometry changes are obtained from the vibronic intensities of the phosphorescence spectrum as well as from a calculation implementing a semi-empirical relation between bond order and bond length. The calculated nonradiative rates compare well with the experimental rates in terms of ab-

solute magnitude and deuterium effect. The semi-empirical calculations of the vibronic intensities provide detailed information about force fields that are otherwise indistinguishable on the basis of their ability to reproduce infrared frequencies. (auth)

114 MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF THIOCARBONYL FLUORIDE, F_2CS. Careless, A. J.; Kroto, H. W.; Landsberg, B. M. (Univ. of Sussex, Brighton, Eng.). Chem. Phys. (Amsterdam); 1: No. 4, 371-375(1973).

The microwave spectrum of thiocarbonyl fluoride, F_2CS, was investigated in the region 26.5 to 40.0 GHz. Transitions of the $^{19}F_2{}^{12}C^{32}S$ and $^{19}F_2{}^{12}C^{34}S$ isotopic species were observed and the derived rotational constants yield the following ground state structural parameters: r(CF) = 1.315 Å ± 0.01, r(CS) = 1.589 Å ± 0.01, and ∠ FCF = 107.1° ± 1.0. The ground state rotational constants of the normal species are (in MHz): A_0 = 11892.6 ± 0.5, B_0 = 5133.03 ± 0.03, and C_0 = 3580.32 ± 0.03. The asymmetry parameter, κ = −0.62640, and the inertial defect Δ^0 = 0.203 u Å^2 which is consistent with that expected for this type of molecule, if planar. The dipole moment was determined from the Stark effect of two lines, and was found to be μ_A = 0.080 D. (auth)

115 CALCULATION OF THE TOTAL DECAY OF ETHYNYLBENZENE AND SOME OF ITS DEUTERATED DERIVATIVES. Friedrich, S.; Griebel, R.; Hohlneicher, G.; Metz, F.; Schneider, S. (Technische Univ., Munich). Chem. Phys. (Amsterdam); 1: No. 4, 330-334(1973).

An absolute calculation of the radiationless decay of the lowest triplet state of ethynylbenzene and some of its deuterated derivatives is presented. The rate constants were evaluated on the basis of Herzberg–Teller coupling. The absolute decay rates and the effect of deuterium substitution are in agreement with experiment within a maximum error of one order of magnitude. The distribution of the electronic energy among the accepting modes is discussed. (auth)

116 MICROWAVE SPECTRA OF THE GROUND AND EXCITED VIBRATIONAL STATES OF ISOTOPIC SPECIES OF NITROETHYLENE. Noesberger, P.; Bauder, A.; Guenthard, H. H. (Federal Inst. of Tech., Zurich). Chem. Phys. (Amsterdam); 1: No. 5, 426-440(1973).

Rotational spectra of nitroethylene, four deuterium and six ^{13}C species have been measured and analyzed in the frequency range from 8 to 26 GHz. Rotational transitions in the ground state, in progressions of excited states of the NO_2 torsional mode ν_{18}, in the in-plane skeletal bending mode ν_{13}, and in doubly excited states $\nu_{13}\nu_{18} + \nu_{18}\nu_{18}$ could be assigned for nitroethylene and its deuterated species. The spectra of the ^{13}C isotopic species were observed in natural abundance and their assignments have partly been checked by microwave–microwave (mw–mw) double resonance. All the spectra in each of the different vibrationally excited states were found to acceptably obey a rigid rotor pattern with centrifugal distortion, corresponding to a high barrier for the NO_2 internal rotation. Rotational constants and inertia defects all show the same qualitative dependence on the internal state. The ground state rotational constants of all isotopic species have been used to determine a refined molecular structure. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 28.

117 TRANSFER OF RADIOACTIVE ANTIMONY(III) FROM MOVING DROPS. Juznic, K.; Barlic, B. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Radiochim. Acta; 19: No. 1, 34-36 (1973).

The transfer of radioactive antimony from rising drops of organic liquid dispersed in an aqueous continuum was measured. The experimental results were analyzed in the light of different mathematical models, namely a model assuming a stagnant drop and models based on circulating liquid in the drop. (GE)

118 METHOD OF OBTAINING HEAVY WATER BY BITHERMAL EXCHANGE BETWEEN LIQUID H_2O AND GASEOUS H_2S. Agostini, J. P. (to Commissariat a l'Energie Atomique). French Patent 2,152,366. 8 Sep 1971. 8p. (In French).

A process is described for obtaining heavy water using bithermal exchange between H_2O and H_2S. The heat exchange process takes place in an installation having a number of stages each possessing a cold tower and a hot tower through which water and gaseous hydrogen sulfide flow in counter-current. The cold and hot towers are completed at their lower end by dehumidifying and humidifying towers respectively. The special features of the process presented are: the liquid flow is integrally taken from the foot of the cold tower and sent into the dehumidifying tower situated below this tower; part of the deuterium enriched liquid flow is taken from the foot of the first loop of the dehumidifying tower after its passage through an exchanger and then sent to the top of the cold tower of the following stage using an intermediate exchanger in such a way as to reduce the temperature of the liquid; the remainder of the deuterium enriched liquid flow traverses the dehumidifying tower and is then sent to the top of the hot tower of the same stage. (FR)

Feed Materials Processing

Refer also to abstract 282.

Radiation Chemistry

Refer also to abstracts 189, 459, 460, 464, 466, 467, and 620.

119 (AEC-tr-7226/9) NUKLEONIKA. Translation of Nukleonika; 17: No. 9, 433-494(1972). 54p. (TT-71-54027/9). Dep. NTIS $5.45.

120 (INIS-mf-1104) STUDIES OF THE SULFOXIDATION OF ALKANES. II. Pulse Radiolysis Study on the Reactions of Cyclohexyl with SO_2 and O_2. Bjellqvist, B.; Reitberger, T. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden)). Feb 1971. 17p. INIS.

The transient absorptions produced by pulses of high-energy electrons into pure cyclohexane or into cyclohexane containing SO_2 or O_2 were studied. The uv-absorption spectra observed are ascribed to cyclohexyl, cyclohexylsulfinyl, or cyclohexylperoxy radicals. The cyclohexylradical spectrum has a maximum at $\lambda \leq 240$ nm and $\epsilon_{240} = (2.3 \pm 0.7) \times 10^3$ M^{-1} cm^{-1}. The cyclohexylsulfinyl radical probably has a maximum at λ = 355 nm $\epsilon_{355} = (1.0 \pm 0.3) \times 10^3$ M^{-1} cm^{-1}. Contrary to what is earlier reported for the cyclohexylperoxyradical only one absorption maximum was found with λ_{max} = 255 nm and $\epsilon_{255} = (4 \pm 1) \times 10^3$ M^{-1} cm^{-1}. The rate-constants for the reactions $C_6H_{11}^{\cdot} + SO_2 \xrightarrow{k_1} C_6H_{11}SO_2^{\cdot}$ and $C_6H_{11}^{\cdot} + O_2 \xrightarrow{k_7} C_6H_{11}O_2^{\cdot}$ were determined to $k_1 = (2.0 \pm 1) \cdot 10^9$ M^{-1} s^{-1} and $k_7 = (3.4 \pm 0.6) \cdot 10^9$ M^{-1} s^{-1}. It is concluded that the competition between these reactions determines the kinetic chain-length in the initial stage of the sulfoxidation of pure hydrocarbons. Reported G-values for the sulfoxidation in the presence of water are higher than expected from this competition and this is attributed to the fact that the first reaction to an appreciable extent takes place in the polar phase. (INIS)

121 (ORO-4179-32) RADIOLYTIC INVESTIGATIONS OF MICELLAR SYSTEMS. Comprehensive Report for the Period April 1, 1971–March 30, 1974. Fendler, J. H. (Texas Agricultural and Mechanical Univ., College Station (USA). Dept of Chemistry). 1974. Contract AT(40-1)-4179. 16p. Dep. NTIS $4.00.

This first Comprehensive Report on "Radiolytic Investigations of Micellar Systems" lists the graduate students trained, postdoctoral and other personnel engaged, journal publications, dissertations, oral presentations in addition to summarizing the research accomplishments, with special reference to the originally stated objectives, for the period April 1, 1971 through March 30, 1974. Present state of knowledge of micellar effects on radiolytic and photolytic processes and their significance in biology and medicine and our future plans are also discussed. (auth)

122 (ORO-4179-33) RADIOLYTIC INVESTIGATIONS OF MICELLAR SYSTEMS. Annual Progress Report, April 1, 1973–March 31, 1974. Fendler, J. H. (Texas Agricultural and Mechanical Univ., College Station (USA). Dept. of Chemistry). 1974. Contract AT(40-1)-4179. 10p. Dep. NTIS $4.00.

This third Annual Report on "Radiolytic Investigations of Micellar Systems" lists the personnel and journal publications in addition to summarizing the scientific activities for the period April 1, 1973 through March 30, 1974. The following are the highlights of these activities. Products formed in the interaction of e^-_{aq}, $\cdot H$, $\cdot OH$ and Cl_2^- with uracil and thymine have been determined. Good material balances have been obtained between the pyrimidines destroyed and products formed in all systems. Techniques for investigating quantitatively quantum yields have been developed. Quantum yields for uracil photodimers and the photohydrate have been determined. Satisfactory material balance has been obtained between ϕ(−uracil) and ϕ(photoproducts). Micellar effects on the products formed in the photolysis and radiolysis of pyrimidines are specific. Pulse radiolytic studies have been carried out on benzophenone, quinones and bile salts. Predominant solubilization sites of benzophenone in different micellar systems have been established by absorption and proton magnetic resonance spectroscopy. (auth)

123 (TID-26558) ESR STUDY OF RADIATION DAMAGE IN PYRIMIDINES. Technical Progress Report. Benson, B. W. (Lehigh Univ., Bethlehem, Pa. (USA). Dept. of Physics). 3 Mar 1974. Contract AT(11-1)-2367. 22p. Dep. NTIS $4.25.

Pyrimidines, particularly barbituric acid derivatives, were used as a model system for the study of radiation damage in biomolecules. Free radical formation in nitropyrimidines was studied. (LK)

124 ANNEALING OF GAMMA-IRRADIATION DAMAGE IN CRYSTALLINE POTASSIUM AND SODIUM CHLORATES. Mohanty, S. R.; Pandey, V. M. (Utkal Univ., Bhubaneswar, India). Radiochim. Acta; 19: No. 1, 22-26(1973).

Kinetics of annealing of chlorite originating in γ-irradiated potassium and sodium chlorates was studied. It was found that annealing in both these substances is a combination of a unimolecular and a bimolecular process. The unimolecular reaction is the recombination of close ClO_2^- and O fragments, $ClO_2^- + O \rightarrow ClO_3^-$, while the bimolecular process is $2\ ClO_2^- + O_2 \rightarrow 2\ ClO_3^-$. (GE)

125 SELECTIVE FREE-RADICAL REACTIONS WITH PROTEINS AND ENZYMES. Pulse Radiolysis and Inactivation Studies on Papain. Adams, G. E.; Redpath, J. L. (Mount Vernon Hospital, Northwood, Eng.). Int. J. Radiat. Biol.; 25: No. 2, 19-138(Feb 1974).

The effect of the selective free radicals $(CNS)_2^-$ and Br_2^- on the activity of papain was studied in neutral and alkaline solution. These radicals were more efficient than the OH radical for inactivating papain in neutral solution. In alkaline solution, OH and Br_2^- were equally effective, whereas $(CNS)_2^-$ was less efficient than OH. The absolute rate constants for the reactions of these radicals with papain were measured as a function of pH for both active and inactive preparations of the enzyme. The transient absorption spectra of the reaction products were also determined. The results showed that tryptophan residues as well as cysteine-25 were essential to the activity of papain. (auth)

126 RADIATION GRAFTING OF VINYLIDENE FLUORIDE TO POLY(VINYL CHLORIDE) FROM THE LIQUID PHASE IN THE PRESENCE OF 1,1-DICHLOROETHANE. Asamov, M. K.; Musakhanova, S. M.; Tkachenko, A. A. (Order of the Red Flag State Univ., Tashkent). Uzb. Biol. Zh.; No. 6, 31-32(1973). (In Russian).

The grafting of vinylidene fluoride to polyvinyl chloride from the liquid phase in the presence of 1,1-dichloroethane by the radiation method is studied. It is shown that the polymerization rate is directly proportional to the dose rate to the degree 0.54. The grafting of vinylidene fluoride to polyvinyl chloride leads to the reduction of the heat stability of the grafted copolymer. (tr-auth)

127 RADIATION CHEMISTRY OF DNA MODEL COMPOUNDS. Part 4. Phosphate Ester Cleavage in Radicals Derived from Glycerol Phosphates. Steenken, S.; Behrens, G.; Schulte-Frohlinde, D. (Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr, Ger.). Int. J. Radiat. Biol.; 25: No. 2, 205-210 (Feb 1974).

An attempt was made to obtain evidence indicating that radiation induced cleavage of phosphate ester bonds in nucleic acid starts from a radical formed by H-abstraction from the sugar moiety of a nucleotide. OH radicals, produced by photolyzing aqueous solutions of H_2O_2 by the in situ ESR technique, were used to abstract H-atoms from glycerol and its phosphates at 2°C over the pH range 1 to 9. It is suggested that at pH < 2, radicals obtained from glycerol were produced by acid-catalyzed elimination of water. On irradiation of H_2O_2, in the presence of glycerol-1-phosphate or glycerol-2-phosphate, analogous elimination of radicals was observed, indicating a rapid elimination of phosphate from the β-phospho radical. In the case of glycerol-1-phosphate it is suggested that this elimination involves the heterolytic rupture of the β C–OP bond followed by deprotonation of the α-hydroxylic H. (UK)

128 IMPROVEMENTS TO SEMIPERMEABLE MEMBRANES. Chapiro, A.; Jendrychowska-Bonamour, A. M. (to Agence Nationale de Valorisation de la Recherche). French Patent 2,151,695. 9 Sep 1971. 7p. (In French)

A process is described for the grafting bulk n-vinylpyrrolidone to a sheet of perhalogenated olefin polymer. In this process, the perhalogenated polyolefin sheet is radiochemically treated in a bath containing n-vinylpyrrolidone and an aromatic solvent, an aromatic natured solvent, or a mixture of two such solvents, the n-vinylpyrrolidone concentration in the bath lying between 20 and 80% (preferably between 30 and 60%). Benzene, toluene, or a xylene may be used as the aromatic solvent; polytetrafluorethylene is used as the perhalogenated polyolefin. (FR)

129 MATRIX ENDOR STUDIES ON INTERMOLECULAR INTERACTIONS OF FREE RADICALS IN DISORDERED SYSTEMS. Bales, B. L. (California State Univ., Northridge); Schwartz, R. N.; Kevan, L. (1973). vp.

From 11th international symposium on free radicals; Berchtesgaden, Germany (4 Sep 1973).

ENDOR spectra of di-p-nitrophenyl nitroxide and di-p-anisyl nitroxide, in the solution of methanol, ethanol, isopropanol, 2-methyltetrahydrofuran, dropped directly into liquid nitrogen to prepare glassy spheres, were studied at 77°K. A line shape model for the ENDOR lines in disordered solids is treated mathematically. The trapped silver atoms in the various matrices were prepared by γ-irradiation at 77°K of the frozen matrix containing a silver salt (0.2 M AgF in H_2O, 0.5 M $AgClO_4 \times H_2O$ in the same alcohols). The spheres were irradiated by ^{60}Co γ-rays at a dose rate of 0.25 Mrad/hr in the dark to a total dose of 1.39 Mrad for AgF in water, 1.75 Mrad for $AgClO_4 \times H_2O$ solutions. (GE)

130 PROCESS FOR PREPARING TELOMERS CONTAINING FLUORINE. Tabata, Y.; Kozima, Y. (to Japan Atomic Energy Research Inst.). Japanese Patent 1973-25416. 3 Dec 1969. 2p.

Telomers containing fluorine are produced by a process which comprises intertelomerizing tetrafluoroethylene and propylene by means of irradiation by ionizing radiations, using halogenated hydrocarbons as a chain transfer agent. Telomers thus produced are greasy and decompose at a temperature higher than 260°C. The degree of polymerization can be controlled by radiation doses. The molecular ratio of tetrafluoroethylene/propylene may be 99/1 to 1/99. The chain transfer agents may be polychloromethane such as chloroform and carbon tetrachloride. Any ionizing radiation may be used at a dose rate between 10^4 and 10^7 rad/hr. The process may be carried out at a temperature ranging from −30°C to 100°C under a pressure ranging from 1 to 100 atm. In one example, 8.2 g of tetrafluoroethylene, 1.8 g of propylene and 15.1 g of chloroform are charged in an ampoule and air is removed. The contents are irradiated by gamma-rays from Co-60 source at a dose rate of 3×10^5 rad/hr for 5 hours so 3.1 g of greasy telomer of molecular weight 3,000 is obtained and decomposes at 235°C. In another example, 8.4 g of tetrafluoroethylene, 1.8 g of propylene and 1.97 g of carbon tetrachloride are fed to an ampoule and the air is removed. The irradiation is carried out with gamma-rays from Co-60 source at a dose rate of 2×10^5 rad/hr for 6 hours. 3.2 g of greasy telomer of molecular weight 3,000 is produced and it decomposes at 230°C. (Iwakiri, K.)

131 HYDROGEN FORMATION IN THE GAS-PHASE RADIOLYSIS OF C_2H_4–D_2O MIXTURES. Kuwabara, K. I.; Hatano, Y. (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 46: No. 11, 3355-3358(Nov 1973).

The total hydrogen yields and their isotopic compositions were measured in the gas-phase radiolysis of C_2H_4–D_2O mixtures at room temperature. A mixture of D_2O (<10 mol %) with a large amount of C_2H_4 was used to avoid the effect of the wall on the decomposition of D_2O. The contribution of thermal hydrogen atoms to the hydrogen formation may reasonably be excluded in this system. The kinetic treatment of D_2 and HD formation suggests the decomposition mechanism of D_2O. No important contribution of hot hydrogen atoms was observed. The yield of hydrogen from the D_2O formed by the unimolecular process, $G_{ID} = 0.4$, was nearly equal to the molecular hydrogen yield reported previously. (auth)

132 CATHODOLUMINESCENCE OF GaP CONTAINING RESIDUAL AND RADIATION DEFECTS. Vil'kotskii, V. A.; Pivovarov, V. Ya. Zh. Prikl. Spektrosk.; 19: No. 6, 1055-1059 (Dec 1973). (In Russian).

In the cathode luminescence spectrum of non-alloyed monocrystals of n-GaP grown from melts at 77°K a series of radiation bands are observed in the visible and infrared regions of the spectrum. These bands are caused by the recombination of bound excitons, impurity and intraimpurity recombination with the participation of residual process impurities of N, S, C, O, and Zn, and structural defects. For the cathode luminescence spectra of epitaxial n-type GaP a substantially reduced intensity with preferential suppression of the exciton radiation is characteristic. The weak structure of the impurity radiation, changing from sample to sample, indicates the relatively low refinement of the material studied. There is significant contamination of the epitaxial GaP with Ar. Irradiation with high-energy particles leads to a reduction in the intensity of the cathode luminescence connected with the reduced lifetime of non-equilibrium current carriers. The efficiency of the degradation of the lifetime depends on the form of irradiation and increases in the order γ quanta, electrons, protons, and fast reactor neutrons. (tr-auth)

133 ADVANCES IN RADIATION RESEARCH. Physics and Chemistry. Volume 1. 4th International Congress of

Radiation Research, Evian, France, June 28–July 4, 1970. Duplan, J. F.; Chapiro, A. (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1973). 357p. (In French and English). (CONF-700610-P1). $25.00.

Separate abstracts were prepared for 23 of the 29 papers presented at the conference. Those not abstracted cover laser photolysis, EPR of chlorophyl triplet state, utilizing the discharge method in photosynthesis, and comparison of photoabsorption and resonance energy transfer processes. (LK)

For abstracts of individual papers see: 134–150, 356, 1772–1775, and 1780.

134 ENERGY TRANSFER EFFECTS IN AROMATIC LIQUIDS. Cundall, R. B.; Evans, G. B. (Univ. of Nottingham, Eng.). pp 69-77 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The results of some selected pulse radiolysis and isomerization experiments for studying excited states are compared. Some methods for separation of singlet and triplet yields of solvent are discussed. (auth)

135 RADIOLYTIC ENERGY TRANSFER INDUCED BY RARE GASES. Kevan, L. (Wayne State Univ., Detroit). pp 89-121 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The type and populations of energy transfer species in irradiated rare gases are discussed. Both monoatomic and diatomic ions must be considered in gases while only diatomic species seem important in condensed phases. Ions dominate 2:1 over excited states. A revised interpretation of the relation between W-values for rare gases and the numbers of ions and excited states is presented. An operational definition of overall energy transfer efficiency in irradiated rare gas-foreign molecule mixtures is applied to available experimental data and the selectivity of product formation by energy transfer is briefly examined. (auth)

136 ENERGY TRANSPORT AND PROTECTION IN CARBOHYDRATE SYSTEMS FOLLOWING γ-IRRADIATION. Phillips, G. O.; Moore, J. S.; Rhys, D. (Univ. of Salford, Eng.). pp 123-130 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Following high-energy irradiation, degradation of crystalline carbohydrates is controlled by an energy transport mechanism that is facilitated by a highly ordered crystal system. Introduction of defects into the lattice leads to protection. The participation of water and hydrogen bonds is indicated by the extreme radiation susceptibility of α-lactose monohydrate (-G ca. 50), where each water molecule is hydrogen bonded to 4 lactose molecules. Complexes were prepared between cycloamyloses, polysaccharides, and glycosaminoglycans of connective tissue and organic molecules, which allow the carbohydrate to be efficiently protected from radiation damage. Such protection is attributed to facile electronic energy transfer in the complexes. (auth)

137 INTERACTION OF LOW-ENERGY ELECTRONS WITH MOLECULES. Kuppermann, A. (California Inst. of Tech., Pasadena). pp 133-143 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Emphasis is placed on the electronic excitation processes and the impact energy range from threshold to about 30 eV above threshold. (MCG)

138 IRRADIATION OF GASEOUS HYDROCARBONS BY ELECTRONS OF LOW ENERGY. Danon, J.; Derai, R.; Millhaud, J. (CNRS, Orsay, France). pp 159-172 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973). (In French).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

An apparatus for irradiation of a flowing gas by a beam of electrons (10 μA) of variable energy (5 to 100 eV) is described. Preliminary results obtained with methane are explained. Recent experiments have shown no hydrocarbons higher than propane are formed. Degrees of conversion for the other products are zero at electron energies below 14 eV and weaker than those indicated in the study at higher energies. The results of the present work have errors due to the presence of residual cleaning solvents. (tr-auth)

139 FREE RADICALS FORMED IN THE GAS PHASE BY THE IMPACT OF LOW ENERGY ELECTRONS: NEOPENTANE, ISOBUTANE, ISOBUTENE. Marx, R.; Mauclaire, G.; Wallart, M. (Faculte des Sciences, Orsay, France). pp 173-181 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973). (In French).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Mechanisms of formation of radicals in neopentane, isobutane, and isobutene gases irradiated with low-energy electrons were studied and an attempt was made to determine the contributions of these different mechanisms: decomposition of molecules or excited ions, ion-molecule reactions, and neutralization of ions. (tr-auth)

140 SLOW ELECTRONS AND NEGATIVE IONS IN ORGANIC LIQUIDS. Hummel, A. (Interuniversity Reactor Inst., Delft, Netherlands). pp 183-198 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

A simplified model of the behavior of the charged entities in the track of a fast electron slowing down in the liquid, based on a predominant contribution of pairs of charged species that can be treated with classical diffusion theory, is discussed. Comparison of the theory with results from measurements of the electric conductance of liquids under irradiation and from observation of ions formed during a short burst of irradiation yields information about the spatial distribution and the behavior of the charged species in the track of a fast electron. (auth)

141 ELECTRON TRANSPORT IN IRRADIATED MODEL CHEMICAL AND BIOLOGICAL SYSTEMS. Adams, G. E.; Willson, R. L. (Mount Vernon Hospital, Northword, Eng.). pp 199-215 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Reactions of slow or thermal electrons in some simple model chemical and biological systems are discussed. Topics include reductive damage in amino acids, peptides and active enzymes, various types of electron transfer phenomena in enzymes, mixed nucleotide solution and electron delocalization in macromolecules. (auth)

142 INTERVENTION OF SINGLET MOLECULAR OXYGEN IN PHOTOBIOLOGICAL AND RADIOBIOLOGICAL PROCESSES. Douzou, P. (Institut de Biologie Physico-Chimique, Paris). pp 217-228 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973). (In French).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Information recently acquired on the formation and properties of the species $^1O_2^*$ is of interest to the photobiologists and radiobiologists for the study of conditions in which H_2O_2 is formed and decomposed as well as its precursor O_2^-, and for the study of enzymatic reactions implied in these processes. (tr-auth)

143 SOME CONTRIBUTIONS OF PULSE RADIOLYSIS TO GENERAL CHEMISTRY. Baxendale, J. H. (Univ. of Manchester, Eng.). pp 229-245 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The development of pulse radiolysis has provided a technique that has applications in many areas of chemistry. Its contributions to date in fields other than radiation chemistry are reviewed. (auth)

144 PULSE RADIOLYSIS. Matheson, M. S. (Argonne National Lab., IL). pp 247-259 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The technique of pulse radiolysis is outlined. Pulsed sources, observation of intermediates, and dosimetry are discussed. Ob-

servations are made on free radicals, ions, solvated electrons, excited molecules, and metal ions of unstable valency in aqueous, organic liquid, and gaseous systems. (LK)

145 MATHEMATICAL ANALYSIS OF FLASH PHOTOLYSIS AND PULSE RADIOLYSIS DATA. Grossweiner, L. I. (Illinois Inst. of Tech., Chicago). pp 261-269 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The high initial yields of intermediates in flash photolysis and pulse radiolysis may require the application of fast reaction theory to the kinetics data, particularly, when macromolecules are involved. Electronic analog and digital computers make it possible to solve the sets of coupled, non-linear, differential rate equations that represent such systems. (auth)

146 STROBOSCOPIC PULSE RADIOLYSIS SYSTEM CAPABLE OF 20 PICOSECOND TIME RESOLUTION. Hunt, J. W.; Bronskill, M. J.; Wolff, R. K. (Ontario Cancer Inst., Toronto). pp 271-278 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

A unique stroboscopic pulse radiolysis system has made it possible to observe e^-_{sol} absorption signals in the time interval from 20 to 350 psec. The time of formation of e^-_{sol} is less than 5 psec in all solvents studied and the relative e^-_{sol} yield in alcohols is the same as that measured at microsecond times. (auth)

147 EPR DETECTION OF SHORT-LIVED FREE RADICALS PRODUCED BY PULSED RADIOLYSIS. Smaller, B.; Remko, J. R.; Avery, E. C. (Argonne National Lab., IL). pp 279-283 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

A detection instrument designed to have response characteristics in the microsecond region is described, and its capabilities in the field of radiation damage in liquids are discussed. (LK)

148 ELECTRICAL CONDUCTIVITY IN THE PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS. Schmidt, K. (Argonne National Lab., IL). pp 285-295 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Two principal methods for measuring transient conductivity changes in pulse-irradiated aqueous solutions are described. Examples are given for the application of the conductivity method for studying charged transient species. Preliminary measurements on photo-generated hydrated electrons and O_2^- ions are reported. (auth)

149 SPECIAL UV TECHNIQUES IN PULSE RADIOLYSIS. The Absorption Spectra of D and OD. Nielsen, S. O.; Pagsberg, P.; Christensen, H.; Nilsson, G. (Danish Atomic Energy Commission Research Establishment, Risoe). pp 297-302 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

A discussion is given of special uv techniques that have proved to be successful in monitoring pulse radiolysis at wavelengths down to 200 nm. Some new data on the absorption spectra of solutions of D and OD in liquid D_2O are presented. (auth)

150 ION-MOLECULE REACTIONS. Futrell, J. H. (Univ. of Utah, Salt Lake City). pp 311-326 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

A brief history of the study of ion-molecule reactions is presented. Single-source, pulsed, tandem, crossed-beam, ion cyclotron resonance, and high-pressure mass spectrometric methods for the measurement of kinetics, mechanisms, and kinematics of these reactions are reviewed. (auth)

151 ADVANCES IN RADIATION RESEARCH. Physics and Chemistry. Volume 2. 4th International Congress of Radiation Research, Evian, France, June 28–July 4, 1970. Duplan, J. F.; Chapiro, A. (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1973). 308p. (In French and English). (CONF-700610-P2). $22.50.

Separate abstracts were prepared for 26 papers presented at the conference. (LK)

For abstracts of individual papers see: 112 and 153–177.

152 RADIOLYSIS OF THE SYSTEM HNO_3–TBP. Broshkevich, R.; Kozlovska-Mil'ner, E.; Novak, Z. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 282-284(1973).

Translated from Radiokhimiya; 15: No. 2, 280-282(1973).

The γ-radiolysis (at 77°K) of a TBP–HNO_3 mixture was investigated, and the results obtained and their interpretation were compared with the work of Bashman and Savel'ev on the system TBP–97% HNO_3. In contrast to the interpretation of these authors, it is assumed that the absence of the NO_3 radical from the ESR spectra of mixtures with a mole fraction of acid x_{HNO_3} = 0-0.8 may occur because of complex formation in the given system. The formation of a complex with the maximum concentration of acid TBP · $4HNO_3$ also affects the curve of the total yield of radicals. (auth)

153 COMPARISON BETWEEN THE RADIOLYSIS OF GASES AND THAT OF THE CONDENSED PHASES. Freeman, G. R. (Univ. of Alberta, Edmonton). pp 351-360 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Differences between gas phase and condensed phase radiolyses appear in reaction kinetics, reaction energetics, and product yields. Most phase effects can be interpreted in terms of the different phase densities and temperature, although crystalline and amorphous forms in solids usually show different radiolysis behavior. (LK)

154 NEW INSIGHTS INTO PRIMARY MECHANISMS OF GAS PHASE RADIOLYSIS BY YIELD MEASUREMENTS AT HIGH DOSE RATES. Willis, C.; Boyd, W. (Chalk River Nuclear Labs., Ont.). pp 361-368 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Nitrogen-oxygen mixtures were irradiated with single pulses at a dose rate of $N2 \times 10^{26}$ eV g^{-1} s^{-1}. The yield measurements at this dose rate and at a low dose rate (10^{16}–10^{18} eV g^{-1} s^{-1}) were used to study the primary mechanisms in gas phase radiolysis. (LK)

155 PULSE RADIOLYSIS: FORMATION OF THE N_3 RADICAL IN GASEOUS NITROGEN MIXTURE. Perner, D.; Bosnali, M. W.; Dreyer, J. W.; Suetterlin, L. (Kernforschungsanlage, Juelich, Ger.). pp 369-376 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The azide radical was found to be formed in mixtures of nitrogen with certain additives under high energy irradiation. The rate constants measured for the formation reaction were of the order of 5×10^{10} to 10^{12} liter per mole per sec, suggesting an ion-molecule reaction. (auth)

156 COMPARISON OF RADIOLYTIC AND PHOTOLYTIC SYSTEMS. Ausloos, P. (National Bureau of Standards, Washington, DC). pp 377-391 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Nearly all activated species formed in gas-phase radiolytic systems can, with the experimental techniques now available, be reproduced in the vacuum ultraviolet photolysis. The two types of systems are thus interchangeable as regards the study of kinetics of the reactions of ions or of free radicals. An important, and useful, difference between photolysis and radiolysis, however, is that in the photolysis at any given energy, a limited number of distinct activated species are formed, whereas a radiolytic system will generally contain a diverse mixture of ions and neutral excited molecules of various energies. This means that results obtained in photolytic systems (in which specific processes can be isolated) can contribute to our understanding of energy deposition in radiation chemistry. (auth)

157 UNIMOLECULAR DECOMPOSITION OF EXCITED IONS. Ottinger, C. (Max-Planck-Institut fuer Stroemorgsforschung, Goettingen, Ger.). pp 405-417 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Three recent techniques for measuring decomposition lifetimes of excited ions are described. Together they span the range 10^{-11} to 10^{-3} sec, with good agreement where they overlap. In addition, charge exchange experiments are reported which have yielded directly the dependence of rate constant on excitation energy. (auth)

158 ELECTRON–ION NEUTRALIZATION IN THE RADIOLYSIS OF GASES. Theard, L. P. (McDonnell Douglas Corp., Huntington Beach, CA). pp 419-428 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Dissociative electron-ion neutralization in the bulk volume of an irradiated gas can be one of the principal modes of chemical conversion at high dose rates and pressures near atmospheric. Neutralization rate constants for many ions can be measured using a superimposed beam technique. Measured rate constants for lower hydrocarbon ions are of the order of 10^{-6} cm^3/molecule-sec. (auth)

159 NONHOMOGENEOUS KINETICS OF IONIC REACTIONS IN ORGANIC LIQUIDS. Freeman, G. R. (Univ. of Alberta, Edmonton). pp 431-439 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

A nonhomogeneous kinetics model that was used in the study on gamma radiolysis of liquids is described and results of recent calculations are presented. (LK)

160 SOLVATED ELECTRONS AND IONS IN ORGANIC SYSTEMS. Magnusson, L. B.; Richards, J. T.; Thomas, J. K. (Betz Labs., Inc., Trevose, PA). pp 441-448 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Pulse radiolysis experiments on liquid hydrocarbons, low-temperature glasses, and mixtures of hydrocarbons, alcohols, and ethers are discussed. The experiments were used to study the nature of ionic species in irradiated systems. (LK)

161 PULSE OPTICAL AND ELECTRICAL METHODS IN INVESTIGATING CERTAIN RADIATION INDUCED IONIC REACTIONS. Bach, N.; Revina, A.; Vannikov, A. (Inst. of Electrochemistry, Moscow). pp 449-458 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The early stage products of alkylketones radiolysis were investigated using pulse irradiation and other methods. Nature, properties, and reactions of the transient species are discussed based on optical, electrical, and paramagnetic effects observed. (LK)

162 IONIC REACTIONS IN γ-IRRADIATED CYCLOHEXANE. Kroh, J.; Karolczak, K. J.; Zegota, H. (Politechnika Lodzka, Lodz, Poland). pp 459-468 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Radiolysis of the C_6H_{12}-C_2H_5OT system was investigated. The yields of G(H_2) and especially G(HT) were found to be sensitive to the presence of electron scavengers. The yield of cyclohexane free ions G_f = 0.12 and reactivity coefficient $\alpha C_2H_5OH = 10^{-2}M^{-1}$. In frozen systems G(HT) is depressed by factor ~20 and shows linear dependence on the concentration of ethanol. In liquid solutions G(HT) is proportional to the square root of ethanol concentration. (auth)

163 SPECTROSCOPIC STUDIES OF ANION RADICALS IN γ-IRRADIATED FROZEN SOLUTIONS. Shida, T. (Inst. of Physical and Chemical Research, Wako, Japan). pp 469-482 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The radiation-chemical method of matrix isolation was applied to the spectroscopic studies of anion radicals. Electronic absorption bands of known intensity can be measured for the ions free from ion-pairing and other complications. Selective photobleaching of the anion provides further information on the electronic states of the ion. Since theories of the electronic states of open-shell molecules are less tested by experiments than the theories for closed-shell molecules, the experimental information obtainable by this method may hopefully induce further studies on odd-electron systems. (auth)

164 APPLICATION OF THERMOLUMINESCENCE METHOD TO THE STUDY OF IONIC SPECIES IN IRRADIATED ORGANIC SOLIDS. Deroulede, A.; Kieffer, F.; Meyer, C.; Rigaut, J. (Faculte des Sciences, Orday, France). pp 483-492 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973). (In French).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

In the glass methylcyclohexane, the cation-electron and cation-anion recombinations produce the same emission spectra (phosphorescence and fluorescence in the same ratio) when the solute is biphenyl. For naphthalene, one observes in addition the fluorescence of the excimer when the concentration is sufficiently high. For durene, the fluorescence of the duryl radical appears at different temperatures according to the gamma radiation doses administered. (tr-auth)

165 CHARGE NEUTRALIZATION AND SCAVENGING IN IRRADIATED CONDENSED MEDIA. Mozumder, A. (Univ. of Notre Dame, IN). pp 493-499 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Neutralization and scavenging of charges created by high-energy radiation in condensed material of low atomic number have been discussed using Smoluchowski's diffusion equation. Both isolated and multiple ion-pair cases are treated. Yield of escaped ions are calculated. Scavenger reaction is evaluated in terms of Laplace transform of neutralization function. A formal derivation of "square root law" for scavenging at low concentration then follows from classical diffusion. (auth)

166 KINETICS OF EXCITON INTERACTIONS IN MOLECULAR CRYSTALS. Pope, M. (New York Univ., NY). pp 501-506 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Excitonic processes and the physical system constants that can be derived from them are described. (LK)

167 FREE RADICALS IN IRRADIATED NAPHTHALENE SINGLE CRYSTALS. Itoh, N.; Chong, T.; Okubo, T. (Nagoya Univ., Japan). pp 507-513 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The optical and EPR properties of the naphthyl and α- and β-hydronaphthyl radicals produced in irradiated naphthalene single crystals are discussed. Possible reactions of these radicals are also discussed. (LK)

168 DISCUSSION OF CHARGE CARRIER GENERATION AND SCINTILLATION UNDER ELECTRON OR PARTICLE BOMBARDMENT. Schott, M. (Groupe de Physique des Solides de l'E.N.S., Paris). pp 515-523 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Using results on charge carrier generation by electron bombardment of anthracene, the scintillation properties of anthracene are considered and satisfactorily explained (yield magnitude, de-

pendence on particle energy, pulse shape variation and anisotropy) when singlet quenching by singlet-triplet interaction is taken into account. (auth)

169 EXCITATION OF FLUORESCENCE OF ANTHRACENE BY LOW ENERGY ELECTRONS. Frankevich, E. L.; Kules, I. (Inst. of Chemical Physics, Moscow). pp 525-533 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Bombardment of an anthracene single crystal by low-energy electrons produces tracks with a volume per single track about 10^{-13} cm^3 at electron energy E = 8 keV, the initial density of excited states in the track being about 10^{16} cm^{-3}. Triplet excitons in such tracks annihilate practically completely. (auth)

170 RADIOTHERMOLUMINESCENCE KINETICS FOR AMORPHOUS ORGANIC SOLIDS. Nikol'skii, V. G.; Tochin, V. A. (Inst. of Chemical Physics, Moscow). pp 535-545 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Activation energy for radiothermoluminescence of amorphous organic solids was investigated by the method of the initial rise. The values obtained are in good agreement with those for molecular motions obtained from the frequency temperature dependence. The shapes of glow curves for de-aerated samples were found to be dose-independent at doses lower than 1 Mrad. Considerably broader peaks on glow curves within the low-temperature range are accounted for by distribution of relaxation times rather than by a single relaxation time. (auth)

171 SCINTILLATION EFFICIENCY ASSESSMENT OF RADIATION DAMAGE IN PLASTIC MEDIA. Hardwick, R.; Schwartzenbach, V. (Univ. of California, Los Angeles). pp 547-553 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

To verify earlier conclusions about the participation of the crystal lattice in the decline of scintillation efficiency after radiation damage, a parallel set of experiments were carried out on plastic scintillators. For a given number of alpha particles, the plastics suffered less efficiency loss than crystals. Damage in plastics cannot be cured by annealing. Since plastics have no lattice these differences should probably be ascribed to that lack of ordered structure. Some plastic fluors are evidently immune to scintillation efficiency loss by radiation damage, while others lose only about a third of their efficiency and then lose little or no more despite continued α bombardment. (auth)

172 IONIC PROCESSES IN IRRADIATED ORGANIC GLASSES. Yoshida, H.; Irie, M.; Hayashi, K. (Hokkaido Univ., Sapporo). pp 555-563 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Cationic processes in irradiated organic glasses were studied by the ESR method. Spectra attributable to positive holes were observed from alkane glasses. When vinylether was added to the glass, this spectra was replaced by the spectra of vinylether cations. Positive hole migration is evidenced by the effect of solutes on the decay of trapped electrons. A spectrum attributable to cationic entities was observed from 2-methyltetrahydrofuran glass, too. (auth)

173 TRI-DIMENSIONAL NETWORK FORMATION IN ELASTOMERS UNDER IRRADIATION. Kuzminskii, A. S. (Inst. of Rubber Industry, Moscow). pp 571-588 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Tri-dimensional network formation (vulcanization) in elastomers is discussed. Several factors determine the type of crosslinks formed in rubbers under irradiation. One of the factors (chemical structure of the polymer) is considered in detail. (LK)

174 IMPROVEMENT OF TEXTILES BY RADIOCHEMICAL GRAFTING. Gaussens, G. Y. (CEN de Saclay, Gif-sur-Yvette, France). pp 589-598 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973). (In French).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The use of ionizing radiation in the improvement of textile products is becoming an industrial reality. Among the new directions of research discussed are the technique of grafting in the vapor phase, as well as the work on the improvement of stain resistance and the facility for washing the textiles. (tr-auth)

175 PERM-SELECTIVE MEMBRANES OBTAINED BY RADIATION GRAFTING: A PROMISING TOOL FOR INDUSTRIAL APPLICATION. Munari, S. (Univ., Genoa). pp 599-621 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Perm-selective membranes were found useful for separating wide varieties of liquid and gaseous mixtures. Many potential applications are just entering in the commercialization phase and look attractive both technically and economically. Appropriate selection of membranes and of operating conditions make possible effective separation. As the driving mechanism of the separation depends on the interaction among the molecules of the mixtures and the membranes, grafted films present an extremely wide range of possibility to select the best properties for a given membrane. Several examples of application and operating mechanisms of membranes, obtained by radiation grafting, are discussed. (auth)

176 COST ANALYSIS AND ECONOMICS OF ELECTRON RADIATION IN INDUSTRIAL CHEMICAL PROCESSES. Simonis, P. J. C. A. (High Voltage Engineering (Europa) N. V., Amersfoort, Netherlands). pp 623-632 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

The cost of hardening a paint with electron radiation is discussed. Capital costs, operating costs per hour, radiation costs per kilogram of material, price of 1 kwh of radiation energy, and reliability and efficiency are considered. (LK)

177 PROGRESS AND PROSPECTS IN PHYSICS AND CHEMISTRY: SUMMING UP. Bosg, J. W. (Inst. of Cancer Research, Sutton, Eng.). pp 633-641 of Advances in Radiation Research. Physics and Chemistry. Vol. 2. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P2.

Some of the highlights of the congress on radiation research are given, including time resolution in pulse radiolysis, exploitation of the fine structure of the electron pulse in a microwave linear accelerator, use of a Q-switched laser for flash photolysis, reactivity of the hydrated electron, luminescence from pulse-irradiated biological molecules, and interest in the singlet excited state of molecular oxygen in the field of radiobiology. (LK)

178 RADIATION CHEMISTRY OF AQUEOUS MICELLAR SYSTEMS. Fendler, J. H.; Bogan, G.; Fendler, E. J.; Infante, G.; Bansal, K. M.; Patterson, L. K. (Texas A and M Univ., College Station). Intra-Sci. Chem. Rep.; 6: No. 4, 1-4(1972). (RRL-3238-364).

The following subjects are discussed: reactivity of e^-_{aq}, $\dot{O}H$, $\cdot H$, and $Cl_2^{\cdot-}$ with micelle-forming surfactants, reactivity of solubilized benzene with e^-_{aq} and $\dot{O}H$ in micellar surfactant solutions, and micellar effects on $Cl_2^{\cdot-}$ reactivities with nucleic acid constituents. Formation of association colloids and substrate solubilization therein substantially affect the rates of radiation-induced reactions. These effects are specific and are dependent on both the nature of the substrate and the charge type of the micelle. The micellar rate enhancements or retardations generally obey Michaeles–Menten kinetics and the magnitude of substrate-micelle binding constants is of the order of 10^4 M^{-1}. Although micellar systems are far from perfect models for complex radiation biological systems, they provide a better approximation than pure water. (LK)

179 EMULSION COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH PROPYLENE BY OH RADICAL FROM PHOTOLYSIS OF H_2O_2–AQUEOUS SOLUTION. Suzuki, N.; Okamoto, J. (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Polym. Lett. Ed.; 12: No. 2, 95-99(Feb 1974).

The role of the OH radical in the emulsion copolymerization of tetrafluoroethylene with propylene was studied. The OH radical is produced by photolysis of an H_2O_2–aqueous solution. (LK)

180 FREE-RADICAL DECAY IN IRRADIATED PMMA. Davis, L. A. (Materials Research Center, Morristown, NJ). J. Polym. Sci., Polym. Phys. Ed.; 12: No. 1, 75-80(Jan 1974).

Data from the literature are analyzed to show that decay of the chain-end radical of PMMA in the regime of 80 to 130°C and 1 to 13000 atm occurs by two mechanisms operating in parallel. These processes are characterized by activation volumes of ca. 70 $Å^3$ (I) and ca. ~7.5 $Å^3$ (II), suggesting that decay by process I occurs by chain-end diffusion and decay by process II occurs by unzipping of the polymer radical to the monomer. (auth)

181 EFFECT OF TEMPERATURE AND PHYSICAL STATE ON THE INHIBITION BY ADDITIVES OF RADIATION-INDUCED DEGRADATION OF POLY(METHYL METHACRYLATE). Wuendrich, K. (Federal Inst. for Materials Testing, Berlin). J. Polym. Sci., Polym. Phys. Ed.; 12: No. 1, 201-212(Jan 1974).

It has been reported in earlier papers that aromatic additives can reduce the rate of radiation-induced degradation of poly(methyl methacrylate) (PMMA), depending on the concentration, the distribution, and the resonance of the aromatic system. In the present work, the temperature dependence is studied, together with the influence of molecular mobility, which is determined by the physical state of the system. For this purpose, PMMA containing benzene, biphenyl, naphthalene, anthracene, phenanthrene, pyrene, or benz[a]anthracene, was γ-irradiated at room temperature and also, except with naphthalene and biphenyl, in the temperature range −80 to 160°C. The changes in degradation rate were related to the first excited singlet state and to the resonance energy of the additives. The results suggest that at low temperatures both electron scavenging and transfer of excitation energy occur. At temperatures between the γ transition and the glass transition, the significance of energy transfer compared with electron scavenging increases, whereas the inhibitory effect decreases. Above the glass transition temperature the inhibition decreases more rapidly. This is related to scavenging of radical chain fragments, due to increasing molecular mobility, which causes a decrease in recombination rate. This sensitization of degradation competes with the inhibition by energy transfer and electron scavenging, and may prevail at temperatures above 185°C. The opposing effects of these mechanisms can be clearly shown with the system PMMA-benzene. In viscous mixtures, sensitization prevails even at room temperature. (auth)

182 IMPROVEMENTS IN OR RELATING TO METHODS OF AND APPARATUS FOR EFFECTING A CHEMICAL SYNTHESIS OR OTHER REACTION UTILISING ELECTRONS IN A SELECTED ENERGY RANGE. Varey, R. H.; Andrews, J. G. (to Central Electricity Generating Board). British Patent 1,337,107. 14 Nov 1973. Filed date 11 Aug 1969. 6p.

The method makes use of an effect known as a double sheath, the double space charge layer that occurs at the junction between two different plasmas. The apparatus consists of a cathode and anode spaced apart and means between them to produce two different plasmas. The products result from a reaction using the electron flux energy at the plasma boundary. The electrons may be produced in a selected energy range up to about 50 eV. (MCG)

183 PROCESS FOR APPLYING A COATING WITH AN AQUEOUS COMPOSITION. Odan, Y.; Kamiyama, H.; Hayashi, K.; Okamura, S. (to Japan Atomic Energy Research Inst.). Japanese Patent 1973-4448. 25 Mar 1969. 5p.

A conductive substrate is coated with an aqueous composition containing an emulsion polymer of ethylene by the cathode deposition method. An aqueous suspension of unsaturated monomer with the ethylene group, in which a cationic surface active agent is contained as an emulsifier, undergoes emulsion is, in turn, electrodeposited onto a conductive substrate at a cathode. In one example, 15 g of water, 1 g of cetyltrimethylammonium chloride, 49 g of methyl acrylate, 1 g of N-methylacrylamide and 0.1 g of laurylmercaptan were poured into a flask at 30°C, nitrogen gas was introduced, and the solution emulsified by γ irradiation using ^{60}Co at a dose rate of 7×10^3 R/h for one hour. To this reaction system were added 49 g of methyl acrylate, 1 g N-methylacrylamide and 0.1 g of mercaptan under the same condition as above for 2.5 h. A stable polymer with a degree of polymerization of 2,000 on the average was obtained with 97.3% yield. After adding 2 g of xylene to 10 g of emulsion, 10 ml of buffer solution consisting of 0.1 N diethanol amine and 0.075 N HCl were added and diluted to 80 g. The emulsion was applied to coating by cathode deposition method. (JA)

184 ACID-BASE PROPERTIES OF FREE RADICALS IN SOLUTION. Hayon, E.; Simic, M. (Army Natick Labs., MA). Accounts Chem. Res.; 7: No. 4, 114-121(Apr 1974).

Unstable free radicals in water, with lifetimes well below $\sim 10^{-2}$ sec at room temperature, were studied. These radicals were produced by pulse radiolysis of aqueous solutions. Both inorganic and organic free radicals were studied. (LK)

185 MECHANISM OF REDUCTION OF PORPHYRINS. A Pulse Radiolytic Study. Harel, Y.; Meyerstein, D. (Nuclear Research Centre Negev, Beersheva, Israel). J. Amer. Chem. Soc.; 96: No. 9, 2720-2727(1 May 1974).

The mechanisms of reduction of hematoporphyrin, PH_2, and its Zn complex, ZnP, by strong single-electron reducing agents in alkaline aqueous solutions were studied. It was found that for both compounds three intermediates are formed prior to the formation of the stable products. The mechanism of reduction of both compounds seems to be the following: (a) $PH_2/ZnP + R^{\cdot -} \rightarrow PH_3\cdot$ or $(PH_2\cdot^-)/(ZnPH\cdot(ZnP\cdot^-)) + R$ (k_1), where k_1 depends on $R^{\cdot -}$; (b) $2PH_3\cdot/2ZnPH\cdot \rightarrow (PH_3)_2/(ZnPH)_2$ ($k_2 = 2.1 \times 10^8$ M^{-1} sec^{-1}), where the dimer is plausibly a π-mer; (c) $(PH_3)_2/(ZnPh)_2 \rightarrow (PH_3)_2'/(ZnPH)_2'$ ($k_{PH_3} = 10$ sec^{-1}; $k_{ZnP} = 17$ sec^{-1}) (this reaction seems to be some kind of rearrangement of the dimer); (d) (here the mechanisms differ) $(PH_3)_2' \rightarrow PH_4$ or $(PH_5^+) + PH_2$ ($k = 0.11$ sec^{-1}) and $(ZnPH)_2' \rightarrow$ Zn(dihydroporphyrin) + ZnP, where PH_4 is a phlorin, whereas in the Zn(dihydroporphyrin) one of the hydrogen atoms is added on a peripheral position. This mechanism is nearly independent of pH in the $7 \leq pH \leq 13$ range and of the solvent water, methanol, or ethanol. The absorption spectra of all intermediates are reported. The reduction of hemin by e^-_{aq} or CH_3CHO^- on the other hand proceeds via direct reduction of the central Fe(III) to Fe(II) in one step. (auth)

186 POSITIVE HOLE MIGRATION IN PULSE-IRRADIATED WATER AND HEAVY WATER. Ogura, H.; Hamill, W. H. (Univ. of Notre Dame, IN). J. Phys. Chem.; 77: No. 25, 2952-2954(6 Dec 1973).

The formation of Cl_2^- at high concentrations of NaCl in pulse-irradiated neutral aqueous solutions is attributed to electronic migration of the positive hole to Cl^- (forming Cl_2^-) and the lifetime of H_2O^+ is limited by formation of H_3O^+. The probability P of forming Cl_2^- will be expressed by $P = \nu_1([Cl^-]/55)/\{[Cl^-]/55 + \nu_2\}$ where ν_1 is the frequency of hole migration and ν_2 is the frequency of H transfer from H_2O to H_2O^+. It has been found that $(\nu_1/\nu_2)_{D_2O} = 1.2$ $(\nu_1/\nu_2)_{H_2O} = 25$ in concentrated aqueous solutions of NaCl and 26 in 1 M $NaC_2H_3O_2$. In dilute solutions of H^+ and Cl^- the specific rate of Cl_2^- formation is 1.17 greater in H_2O than in D_2O. The ratio (ν_1/ν_3) at 100°/(ν_1/ν_2) at 25° ≅ 1.1 in H_2O and in D_2O after correcting for thermal expansion. It is proposed that neither ν_1 nor ν_2 involves thermal activation and that H transfers to H_2O^+ at a frequency 2×10^{14} sec^{-1}. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 1988 and 1989.

187 RADIOCHEMICAL STUDY OF GAS PHASE REACTIONS OF FREE METHYL CATIONS WITH ETHYLENE AND AN ETHYLENE–WATER MIXTURE. Nefedov, V. D.; Sinotova, E. N.; Akulov, G. P.; Korsakov, M. V. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 289-292(1973).

Translated from Radiokhimiya; 15: No. 2, 286-288(1973).

A study was made of the reaction of free carbonium ions with ethylene in the gas phase and with an ethylene–water mixture. It was shown that polymerization processes may proceed by a cationic mechanism in the gas phase and the nature of the intermediate carbonium ions was elucidated. (auth)

Properties of Radioactive Materials

Refer also to abstracts 83, 92, 119, 282, 698, 701, 746, and 2211.

188 (AAEC/LIB/Bib-407) URANIUM(III). A Bibliography, 1965-1973. Geue, P. J. (comp.). (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1973. 22p. Dep. NTIS (U. S. Sales Only) $4.25.

Sixty-six references are arranged chronologically and alphabetically by author within each year. A section on bibliographies and reviews (4 refs.) is included. The references center mainly on redox processes and reaction kinetics of uranium (III) compounds. (AT)

189 (AEC-tr-7226/7-8) NUKLEONIKA. Translation of Nukleonika; 17: No. 7-8, 351-432(1972). 78p. (TT-71-54027/7-8). Dep. NTIS $5.45.

190 (AEC-tr-7505) THERMOCHEMISTRY OF COMPOUNDS OF RARE-EARTH AND ACTINIDE ELEMENTS. Krestov, G. A. (Joint Publications Research Service, Washington, D. C. (USA)). 1972. Translation of Termokhimiya Soedinenii Redkozemel'nykh i Aktinoidnykh Elementov, Moscow, Atomizdat, 1972. 253p. Dep. NTIS $7.60.

Little known and unpublished problems of the thermochemistry of compounds of rare-earth and actinide elements are presented in this book from the point of view of contemporary concepts. A systematic examination of the dependence of interionic distances and crystallochemical radii of ions on temperature is presented for the first time. Methods and approaches which the author developed are used for determining many unknown properties of ions and simple compounds of certain rare-earth and actinide elements at various temperatures (thermodynamic, structural, etc.) and the changes which they undergo during ionization, hydration, dissolution, formation and ionic sublimation. The latest achievements in the theory of hydration of ions, structure of water and ionic solutions are discussed. The book contains tables of the thermodynamic and structural properties of these compounds and their changes during the stated processes at various temperatures. The book includes 64 tables, 41 illustrations, and 310 bibliographic references. (auth)

191 (DPSPU-74-30-10) DECONTAMINATION OF A HIGHLY RADIOACTIVE CHEMICAL PROCESSING FACILITY. Moore, P. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Plant). [nd]. 11p. (CONF-740406-6). Dep. NTIS $4.00.

From second AEC pollution control conference; Albuquerque, New Mexico, USA (16 Apr 1974).

Five modules of the highly radioactively contaminated "hot canyon" in one of the chemical processing plants for irradiated fuel at Savannah River Plant were successfully decontaminated for installation of a new process. Decontamination was completed in about one year at a cost of about $150,000. The various techniques employed, equipment used, and the overall job plan are described. (auth)

192 (FRNC-TH-442) STUDY OF THE BEHAVIOR OF CARRIER FREE TETRAVALENT TECHNETIUM IN AQUEOUS MEDIA. Guennec, J. Y. (Paris-11 Univ., 91-Orsay (France)). 1973. 104p. (In French). Dep. NTIS (U. S. Sales Only) $8.25.

Thesis.

The behavior of tetravalent technetium in perchloric media was studied. Investigations of acid solutions containing only technetium(IV) can be effected using the solvent extraction technique. Tc(IV) was extracted by organic phases (containing or not containing a chelating agent) from Tc(VII) solutions reduced by BH_4^- at a pH value > 7. These organic phases are subsequently opposed to aqueous phases of $HClO_4$ (5.10^{-2} to 3M). The variations in the distribution coefficients were studied as a function of the chelating agent concentration and the pH. The reduction of Tc(VII) in hydrochloric media was also studied. The $TcCl_6^{2-}$ ion exists in very acid media (12 to 1M HCl). When the Cl^- concentration is less than 1M, the addition of chloride ions leads to a new neutral species which might be $TcOCl_2$. When the Cl^- concentration is greater than 1M, a species is formed which might be $TcOCl_3^-$. The behavior of Tc during the formation of the Tc-Fe-ascorbic acid complex was studied, this complex having applications in medical scintigraphy. Investigations of carrier-free Tc necessitated the use of radiochemical methods such as chromatography and solvent extraction. The ^{99m}Tc isotope was used for these studies. (FR)

193 (LF-46, pp 1-9) DEVELOPMENT AND USE OF A SYSTEM FOR ROUTINE PRODUCTION OF MONODISPERSE PARTICLES OF $^{238}PuO_2$ AND EVALUATION OF GAMMA EMITTING LABELS. Raabe, O. G.; Boyd, H. A.; Kanapilly, G. M.; Wilkinson, C. J.; Newton, G. J. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

A system has been designed, constructed, tested and used for producing monodisperse ($\sigma_g < 1.2$) particles of $^{238}PuO_2$ which are being used in inhalation experiments with dogs and rodents. The system consists of a series of five stainless steel glove boxes housing the aerosol generation system, heating columns for heat treatment of the aerosols, an aerosol chamber, four Lovelace Aerosol Particle Separator (LAPS) units and associated equipment. Polydisperse aerosols are produced by nebulization of $Pu(OH)_4$ dispersed in 0.6 M HCl and passed through two heating columns, one at 320°C and one at 1150°C, to yield PuO_2 particles. These are introduced into an aerosol chamber from which samples can be drawn into the four LAPS units where the particles are separated and collected on metal foils according to aerodynamic equivalent diameter. After many hours of operation, when the LAPS units contain sufficient material, the LAPS foils are removed and cut into small segments containing particles with coefficient of variation less than 10% based on aerodynamic diameter. The particles of PuO_2 on each are suspended in aqueous solutions containing a suitable surfactant and nebulized to provide monodisperse aerosols of $^{238}PuO_2$ particles. The use of ^{51}Cr and ^{169}Yb as γ labels for $^{238}PuO_2$ has been studied. (auth)

194 (LF-46, pp 31-35) PRODUCTION OF ^{198}Au TAGGED AEROSOLS FOR USE IN INHALATION DEPOSITION STUDIES. Newton, G. J.; Raabe, O. G.; Yarwood, R.; Phalen, R. F. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

A method for production of polydisperse and monodisperse ^{198}Au aerosol particles ($\rho \approx 19.3$) is described. Neutron activation of stable gold was used to provide sensitive detection of the aerosol. Activity levels in μCi per liter of test aerosols for respirable-sized particles from 0.06 to 1.0 μm real diameter are described. (auth)

195 REACTION OF PLUTONIUM TRIIODIDE WITH SODIUM IN LIQUID ANHYDROUS AMMONIA. Cleveland, J. M.; Bryan, G. H.; Heiple, C. R.; Stronen, R. J. (Dow Chemical Co., Golden, CO). Contract AT(29-1)-1106. J. Amer. Chem. Soc.; 96: No. 7, 2285-2286(3 Apr 1974).

Plutonium nitride of relatively high purity was obtained by reduction of Pu(III) iodide with alkali metal–ammonia solutions. Conclusions based on elemental and infrared analyses that the product was plutonium nitride could not be verified by x-ray powder diffraction analysis, because of the lack of crystals large enough to permit a pattern to be obtained. The possible reaction mechanisms are discussed. (MCG)

196 INFRARED SPECTRA OF URANYL COMPLEXES WITH DI-N-BUTYLPHOSPHORIC ACID TRI-N-BUTYLPHOSPHINOXIDE, AND TRI-N-OCTYLAMINE. Komarov, E. V.; Yasnovitskaya, A. L. Zh. Prikl. Spektrosk.; 19: No. 6, 1069-1074(Dec 1973). (In Russian).

The results of the study of the infrared spectra of compounds of di-n-butyl phosphonic acid with uranyl tri-n-butylphosphinoxide, tri-n-octylamine, and di-n-butylphosphate in CCl_4 are reported. The assignment of the bands in the infrared spectra, based in a large part on published studies and on the results of calculations made by use of the theory of molecule oscillation, is given. In contrast to published data the spectra of the DBP compounds with uranyl is obtained by slow scanning of the spectra which is used to clarify detailed structure of a series of absorption bands. From the results of the study of the characteristics of the oscillation spectra of different compounds containing the grouping $(-H_2CO)_2$-POO^-, the characteristic combinations of the band in the spectra of the $\succ POO^-$ group with P → 0 equivalent bonds are found. (tr-auth)

197 ADSORPTION OF NEPTUNIUM ON A POLISHED PLATINUM SURFACE. Samartseva, A. G.; Zhuravleva, Z. A Sov. Radiochem. (Engl. Transl.); 15: No. 2, 158-163(1973).

Translated from Radiokhimiya; 15: No. 2, 161-167(1973).

A study was made of the adsorption and desorption of tracer amounts of $Np^{(IV)}$ on a polished platinum surface in HNO_3 solutions in relation to the concentration of hydrogen ions over the range $10^{-1}-10^{-12}$ M. It was established that up to pH 3 the adsorption of $Np^{(IV)}$ on platinum is insignificant (1 to 2%), at pH 3 to 4 its adsorption increases to 20%, and at pH 9 to 10 it reaches 50%. It is suggested that the second adsorption maximum of $Np^{(IV)}$ in an alkaline medium appears as a result of oxidation of $Np^{(IV)}$ to $Np^{(VI)}$ since the character of the curve in this region of pH values coincides with the analogous curve for $Np^{(VI)}$. A study was made of the adsorption of $Np^{(V)}$ on a polished platinum surface in nitric acid solutions in relation to the hydrogen ion concentration over the range of $10^{-1}-10^{-12}$ M. It was established that pentavalent neptunium is hardly adsorbed on a platinum surface at pH values of 1–12 (0.1–0.2%). A study was made of the adsorption of $Np^{(VI)}$ on a polished platinum surface in HNO_3 solutions in relation to the hydrogen ion concentration over the range of $10^{-1}-10^{-12}$ M. It was established that appreciable adsorption of it begins at pH > 7 with the formation of a sharp maximum at pH 9.0 at a height of ~35%. The adsorption curve obtained for $Np^{(VI)}$ completely coincides with the analogous curve for $Pu^{(VI)}$, but differs sharply from the analogous curve for $U^{(VI)}$. On the basis of the results obtained it was concluded that the state of $Np^{(VI)}$ and $Pu^{(VI)}$ in HNO_3 solutions differ sharply from the state of $U^{(VI)}$ at the same pH values. (LK)

198 ADSORPTION OF CURIUM ON POLYTETRAFLUOROETHYLENE. Samartseva, A. G.; Zhuravleva, Z. A. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 154-157(1973).

Translated from Radiokhimiya; 15: No. 2, 156-160(1973).

Adsorption of curium on PTFE was studied as a function of the concentration of hydrogen ions over the range 10^{-1} to 10^{-12} M. It was established that the form of the adsorption curve for curium on PTFE is identical to the analogous curve for adsorption of curium on platinum. It is proposed that the adsorption of curium on PTFE and on a platinum surface proceeds by analogous ion-exchange mechanisms. A study was made of the desorption of curium from a PTFE surface by solutions with the same pH values as those used in studying adsorption. It was established that the adsorption of curium on PTFE up to pH 4.5-5.0 is reversible. Consequently, the adsorption of curium on PTFE in this pH range involves an ionic and not a molecular form of the radioactive element. The kinetics of adsorption of curium on PTFE were studied at different pH values. It was established that the adsorption of curium on PTFE at pH 4.3 is complete in 1 to 1.5 h and at pH 3.8 in 15 to 20 min, which is characteristic of ion-exchange and not molecular adsorption of the radioactive element. An investigation was made of the adsorption saturation of a PTFE surface by curium by repeated immersion of the adsorbent surface in fresh curium solutions. It was shown that with 16 immersions of the same adsorbent surface in new curium solutions the adsorption power of PTFE changes insignificantly. (auth)

199 COMPLEX FORMATION IN THE SYSTEMS URANIUM HALIDE-ALKALI METAL HALIDE. Forms of Compounds in the Systems Uranium Tetrabromide-Alkali Metal Bromide and Their Structural Characteristics. Vdovenko, V. M.; Kozhina, I. I.; Suglobova, I. G.; Chirkst, D. E. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 168-172(1973).

Translated from Radiokhimiya; 15: No. 2, 172-177(1973).

Thermographic and x-ray investigations of the salt systems UBr_4-MBr (M = Na, K, Rb, Cs) showed that the systems examined the complex compounds formed have only the one form M_2UBr_6 and these are congruently melting and their melting points rise with an increase in the atomic number of the alkali metal. With a decrease in the atomic number of the alkali metal and cubic face-centered lattice of Cs_2UBr_6 and Rb_2UBr_6 undergoes distortion with a change to the tetragonal lattice of K_2UBr_6. Na_2UBr_6 has a hexagonal lattice. (auth)

200 IR ABSORPTION SPECTRA OF SOME NEPTUNIUM COMPOUNDS. I. Hydroxides, Nitrates, and Sulfates. Kharitonov, Yu. Ya.; Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 177-181(1973).

Translated from Radiokhimiya; 15: No. 2, 181-186(1973).

A qualitative study was made of the ir absorption spectra of some compounds of neptunium with hydroxyl, nitrate, and sulfate groups. On the basis of the experimental data obtained hypotheses are put forward on the structure of the compounds studied. (auth)

201 KINETICS OF SOLUTION OF URANIUM DIOXIDE IN NITRIC ACID SOLVATES. Filippov, A. P.; Strelkov, L. A. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 182-189(1973).

Translated from Radiokhimiya; 15: No. 2, 186-194(1973).

By the rotating disk method we investigated the solution of uranium dioxide in solvates of nitric acid with TBP and D2EHPA and TOA nitrate. A study was made of the relation of the physicochemical properties of solutions of nitric acid in TBP, D2EHPA, and TOA to their composition; the formation constants and the concentrations of HNO_3 solvates in the organic phase were calculated. It was shown that the determining factor in the solution process in solvates of nitric acid with extractants is the presence of a solvate with two molecules of HNO_3 in the organic solution. The regions in which the process occurs were established. In the diffusion region (ω < 500 rpm) the limiting stage is diffusion of the reaction products; in the kinetic region the limiting stages are decomposition of nitric acid (t = -16-0°) and oxidation of uranium (t = 0-50°C). (auth)

202 KINETICS OF REDUCTION OF NEPTUNIUM BY HYDRAZINE. II. Reduction of Np(VI) to Np(V) in Nitric Acid. Koltunov, V. S.; Tikhonov, M. F. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 190-194(1973).

Translated from Radiokhimiya; 15: No. 2, 194-199(1973).

A study was made of the kinetics of reduction of neptunium(VI) by hydrazine in nitric acid with an ionic strength μ = 2 over the temperature range 20-40°C. It was shown that the kinetic equation for the reaction and the mechanism in HNO_3 are analogous to those for the reaction in perchloric acid, which was studied previously. Reasons are put forward for the catalytic action of nitrate ions. The thermodynamic parameters of activation were calculated. (auth)

203 DETERMINATION OF ACTIVITY COEFFICIENTS OF TRIVALENT ACTINIDE AND LANTHANIDE IONS IN AQUEOUS SOLUTIONS OF SODIUM NITRATE. Chudinov, E. G.; Pirozhkov, S. V. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 195-199(1973).

Translated from Radiokhimiya; 15: No. 2, 200-204(1973).

A study was made of the relation of the distribution coefficients of Am, Cm, Bk, Cf, Es, Ce, Pm, and Eu to the concentration of sodium nitrate in extraction by trioctyl-, methyldioctyl-, propyldioctyl-, and tetraoctylammonium nitrates. From the extraction data we calculated the apparent mean molar activity coefficients of these trivalent actinide and lanthanide elements in sodium nitrate solutions. It was shown that the change in the activity coefficients in the organic phase from the activity of water in the aqueous phase is the same for all the alkylamines studied. (auth)

204 USE OF DIFFERENTIAL SPECTRA TO STUDY EQUILIBRIA IN SYSTEMS WITH SEVERAL COMPLEXES. II. Lower Chloride Complexes of Neptunium(IV). Barbanel, Yu. A.; Murav'eva, L. P. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 221-228(1973).

Translated from Radiokhimiya; 15: No. 2, 227-236(1973).

By analysis of the differential spectra of neptunium (IV) in aqueous solutions of (9-x) M $HClO_4$ + x M HCl it was shown: (a) when $C_{Cl^-} < 10^{-2}$ M a single complex ($NpCl^{3+}$) dominates; (b) in the region where 10^{-2} M < C_{Cl^-} < $5 \cdot 10^{-2}$ M two complexes are present and these differ in one ligand particle ($NpCl^{3+}$ + $NpCl_2^{2+}$); (c) when $C_{Cl^-} > 5 \cdot 10^{-2}$ M more than two complexes are present in solution. A method is proposed for calculating the spectra of the lowest complex from the differential spectra. The absorption spectra of the complexes $NpCl^{3+}$ and $NpCl_2^{2+}$ were calculated. The stability constants of the complexes $NpCl^{3+}$ and $NpCl_2^{2+}$ were determined: $K_1 = 1.33 \cdot 10^2$, $K_2 = 1.1 \cdot 10^3$. The reasons for the increase in the stability of the complexes in solutions with a high concentration of $HClO_4$ were examined. As a result of a comparison with data obtained earlier for nitrate complexes of $Np^{(IV)}$ it was concluded that chloride ions have a greater tendency to form complexes: $Cl^- > NO_3^-$. (auth)

205 IR ABSORPTION SPECTRA OF SOME NEPTUNIUM COMPOUNDS. II. Sulfite Complex $NH_4NpO_2SO_3 \cdot H_2O$. Kharitonov, Yu. Ya.; Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 237-239(1973).

Translated from Radiokhimiya; 15: No. 2, 244-246(1973).

The infrared spectrum of $NH_4NpO_2SO_3 \cdot H_2O$ was obtained. The vibration frequencies found and their assignments are given. (LK)

206 IR ABSORPTION SPECTRA OF SOME NEPTUNIUM COMPOUNDS. III. Carbonate Compounds. Kharitonov, Yu. Ya.; Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 240-243(1973).

Translated from Radiokhimiya; 15: No. 2, 246-249(1973).

The infrared spectra of $Na_4Np(CO_3)_4 \cdot xH_2O$, $K_6Np(CO_3)_5 \cdot xH_2O$, $NH_4NpO_2CO_3 \cdot xH_2O$, $NpO_2CO_3 \cdot xH_2O$, and $(NH_4)_4NpO_2(CO_3)_3$ are discussed. (LK)

207 REACTION OF POLONIUM WITH HAFNIUM. Ershova, Z. V.; Prokin, E. S. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 247-249(1973).

Translated from Radiokhimiya; 15: No. 2, 252-254(1973).

Hafnium monopolonide was obtained by the reaction of polonium vapor with heated metallic hafnium in evacuated quartz ampoules. The limit of thermal stability of hafnium polonide is given and the vapor pressure of polonium over the polonide in the temperature range of 700-900°C was measured. (auth)

208 SYSTEM UO_3-MoO_3-H_2O. Serezhkin, V. N.; Kovba, L. M.; Trunov, V. K. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 285-288(1973).

Translated from Radiokhimiya; 15: No. 2, 282-285(1973).

An x-ray diffraction study of the system UO_3-MoO_3-H_2O was made. Aqueous suspensions of calculated amounts of $UO_2(OH)_2$ and MoO_3 were put in thick walled quartz ampules, which were then sealed and heated. The synthesized samples were studied by x-ray diffraction to determine their structures. (LK)

209 EFFECTS OF MIXED AND IONIC CONDUCTION ZrO_2 AND ThO_2 AS CO OXIDATION CATALYSTS. Berkstresser, G. W.; Brook, R. J.; Whelan, J. M. (Univ. of Southern California, Los Angeles). J. Mater. Sci.; 9: No. 3, 491-493(Mar 1974).

A comparison is made of the heterogeneous catalytic activities of ZrO_2, $Zr_{0.91}Ca_{0.09}O_{1.91}$, and $Th_{0.85}La_{0.15}O_{1.925}$ for the oxidation of CO by O_2. A correlation is evident with the magnitudes of the simultaneous bulk ionic and electronic conductivities. This is in accord with a postulated model for reaction at separate reactant

absorption sites in which oxygen ions and electronic charge are transported in and on the surface of the oxide catalyst. (auth)

Radioactive Waste Treatment

Refer also to abstracts 221, 999, 1852, and 1918.

210 (CONF-731117-4) USE OF INORGANIC SORBENTS FOR THE ACCUMULATION AND MONITORING OF RADIOIODINE IN GASEOUS WASTES AND IN THE VICINITY OF NUCLEAR POWER STATIONS. Hladky, E.; Pietrik, I.; Moravek, J. (Vyskumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia)). [nd]. Translation of SM-180-79. 15p. Dep. NTIS (U. S. Sales Only) $3.00.

From symposium on environmental surveillance around nuclear installation; Warsaw, Poland (5 Nov 1973).

The results of a detailed study of inorganic sorbents based on alumina saturated with $AgNO_3$ have clearly shown that these materials are suitable for collecting radioiodine and for detecting it in a nuclear power station or in the vicinity of nuclear installations. The sensitivity of the detection of radioiodine and its compounds by the described equipment, using alumina saturated with $AgNO_3$, is 10^{-14} to 10^{-12} Ci/liter after collection of a sample of air in the flow of the gas. Although the method and the corresponding equipment were originally developed for continuous monitoring of the level of activity of iodine in the ventilation shaft of a nuclear power station, we feel it is possible to use the very same equipment in practice to monitor the radioiodine level in the vicinity of a nuclear power station. (LK)

211 (DP-1330) RECOVERY OF PLUTONIUM-238 FROM SCRAP MATERIALS. Russell, E. R.; Thompson, M. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Apr 1974. Contract AT(07-2)-1. 20p. Dep. NTIS $4.00.

Processes were developed and demonstrated for the recovery of ^{238}Pu from scrap from fuel form research, development, and production. The scrap materials studied were PuO_2-Mo and PuO_2-ThO_2-Mo cermets, PuO_2-ThO_2 and PuO_2-ZrO_2 solid solutions, PuO_2-Be, Pu metal Pu-Zr alloy, and miscellaneous wastes containing iron oxides. Metals and oxides, e.g., Mo, Be, and Fe, that interfere with PuO_2 dissolution in nitric acid containing fluoride ions are removed first. Molybdenum and its oxides are dissolved by 1.5M HNO_3-0.5M $Fe(NO_3)_3$ or solid $Fe(NO_3)_3 \cdot 9H_2O$. Beryllium metal is dissolved by 10M HNO_3. Iron oxides are dissolved by 2M HNO_3. Plutonium metal and Pu-Zr alloy are oxidized to obtain oxides. Plutonium oxide and its solid solutions are dissolved in 10 to 14M HNO_3 with 0.05 to 0.2M F^-; aluminum is added to reduce corrosion of stainless steel. The plutonium is purified by anion exchange. (auth)

212 CONTINUOUS SAMPLING FOR DETECTING TRITIATED WATER. Koenig, L. A.; Wilhelm, J. G.; Dillmann, H. G. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 18: No. 12, 582-583(Dec 1973). (In German).

A description is given of a procedure to condensate tritiated water from moist gaseous wastes and of the required sampling equipment. (GE)

Radioisotope Production

Refer also to abstract 27.

213 SEPARATION OF PLUTONIUM-238 FROM FISSION PRODUCTS BY SOLVENT EXTRACTION USING HDEHP. Akatsu, J. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 11, 696-699(Nov 1973).

A procedure for separating ^{238}Pu from a Np sample irradiated with neutrons is described. Rapid separation of Pu by HDEHP solvent extraction was attempted, and without adjusting its valency states in the dissolver solution of the sample. Both Pu(IV) and Pu(VI) were extracted along with Np from the HNO_3 solutions of various concentrations. The Pu and Np extracted in the organic solution were backextracted with oxalic acid solutions. The decontamination factors of the crude products were of the order of 10^2 for gross γ-activity. The Pu in the products was separated from Np by means of ion exchange resin columns. Approximately 0.5 mg of ^{238}Pu was obtained with an efficiency exceeding 95%. (auth)

214 SEPARATION OF PURE ^{248}Cm FROM ^{252}Cf BY EXTRACTION CHROMATOGRAPHY. Baybarz, R. D.; Knauer, J. B. Jr. (Oak Ridge National Lab., TN). Radiochim. Acta; 19: No. 1, 30-33(1973).

A process was developed using bis(2-ethylhexl) phosphate sorbed on a granular, porous glass support (Bio-Glas 500). Various concentrations of HNO_3 were used as the elutriants. The physical properties of the glass support matrix provided excellent operating characteristics of the process in an ion-exchange mode. Decontamination factors for $^{248}Cm/^{252}Cf$ were determined. The process was developed as a high pressure system for hot-cell operation to complement existing cation exchange techniques in the isolation and purification of milligram quantities of pure ^{248}Cm. (GE)

215 SEPARATION OF THE ISOTOPES NIOBIUM-95 AND ZIRCONIUM-95 BY EXTRACTION WITH HEXAMETHYLENEAMMONIUM HEXAMETHYLENEDITHIOCARBAMATE IN CHLOROFORM. Byr'ko, V. M.; Busev, A. I.; Kovtun, N. P. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 255-257(1973).

Translated from Radiokhimiya; 15: No. 2, 258-261(1973).

For the separation of ^{95}Nb and ^{95}Zr, niobium is extracted for 15 min with a 0.5% solution of hexamethyleneammonium hexamethylenedithiocarbamate in chloroform from 7 to 8 N HCl solution. The zirconium remains in the aqueous phase while 98% of the niobium is extracted. (auth)

216 SEPARATION OF ACTINIDES AND LANTHANIDES ON ZIRCONIUM PHOSPHATE. IV. Separation of Milligram Amounts of Americium and Curium. Shafiev, A. I.; Efremov, Yu. V.; Andreev, V. P. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 263-265(1973).

Translated from Radiokhimiya; 15: No. 2, 265-267(1973).

Milligram amounts of americium and curium were separated on zirconium phosphate. It was shown that this method may be used for separating weighable amounts of americium and curium. (auth)

217 RADIOCHEMICAL PURIFICATION OF IRON-55 BY EXTRACTION IN THE PRESENCE OF HNO_3. Danilin, L. D.; Pavlova-Verevkina, A. I. Sov. Radiochem. (Engl. Transl.); 15: No. 2, 217-220(1973).

Translated from Radiokhimiya; 15: No. 2, 223-227(1973).

By an investigation of the extraction of $Fe^{(III)}$ and $Mn^{(II)}$ in the system HNO_3-H_2O-LiCl-MBK it was shown that practically quantitative isolation of ion (III) is possible from a nitric acid solution with C_{HNO_3} up to 2.0 M. At the same time ~1% $Mn^{(II)}$ passes into the organic phase. Washing the latter with a neutral 5.7 M LiCl solution considerably improves the separation. With an increase in the concentration of $Fe^{(III)}$ in the aqueous phase K_d of the latter falls strongly. (auth)

218 NOVEL METHOD OF ^{123}I-PRODUCTION FOR RADIODIAGNOSTICAL PURPOSES. Cauwe, F.; Deutsch, J. P.; Favart, D.; Prieels, R.; Cogneau, M. (Univ. Louvain, Belg.). Int. J. Appl. Radiat. Isotop.; 25: No. 4, 187-188(Apr 1974).

Production of ^{123}I via the $^{124}Te(p, 2n)^{123}I$ reaction has been undertaken using protons from an isochronous cyclotron. The incident protons of 25 ± 0.1 and 35 ± 0.1 MeV bombarded a 300 $\mu g/cm^2$ ^{124}Te target enriched to 93.4 per cent in ^{124}Te. The target was deposited on 1.25 mg/cm^2-thick Mylar. The method proved superior to expectations by about 50% and one can expect from an optimum target thickness (900 mg/cm^2) a yield of about 40 $mCi/\mu Ah$, which is thought to be the highest yield obtainable to date for the production of ^{123}I. The radio-toxicity of the product is somewhat greater than from reactions proceeding via ^{123}Xe but remains sufficiently low (compared to the radiotoxicity of the conventional ^{131}I) if shelve-times lower than 24 h can be afforded. The other drawback of the method, the considerable target-investment (£1·6/mg) does not seem prohibitive in view of the possibility to use the same target several times and considering also the cost of the irradiation itself, which can be greatly reduced if a high-yield production reaction is used. (UK)

219 CHEMICAL SEPARATION OF ^{18}F. Application to an Aluminum Target. Benmalek, M.; Chermette, H.; Martelet, C.; Sandino, D.; Tousset, J. (Univ. Claude Bernard, Lyon). J. Radioanal. Chem.; 16: No. 1, 215-220(1973). (In French).

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A rapid and quantitative separation method of ^{18}F in aluminium target, using solvent extraction is presented. Conditions required for aluminium complexation and solvent extraction by means of triphenylantimony dichloride are discussed allowing ^{18}F to be finally obtained totally free from all other radiocontaminants. (auth)

220 PRODUCTION OF BISMUTH-204 FOR MEDICAL USE Kinsley, M. T.; Lebowitz, E.; Baranosky, J. (Brookhaven National Lab., Upton, NY). Int. J. Nucl. Med. Biol.; 1: 85-92(1973).

A method is described for producing practical quantities of high-purity ^{204}Bi by the $^{206}Pb(p, 3n)^{204}Bi$ reaction. A simple chemical separation method with good yield has been developed. The cross section for the above reaction was calculated for 32-MeV protons.

Decay data for $^{204}Bi-^{204m}Pb$ equilibrium samples are also reported. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 374 and 2151.

221 (74-SD-4209) REPORT ON THE AVAILABILITY AND COST OF CURIUM-244 FROM REACTOR FUEL REPROCESSING WASTE. Brown, P. E.; Garate, J. A. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 15 Feb 1974. Contract AT(29-2)-2831. 99p. Dep. NTIS $8.00.

A study on the cost and availability of recovering ^{244}Cm from the waste resulting from the reprocessing of power reactor fuel is reported. The synthesis of ^{244}Cm is reviewed and the processes and facilities for ^{244}Cm recovery are discussed. (LK)

222 (AEC-tr-7535) OBTAINING THE ACTINIDE ELEMENTS AND REUSABLE FISSION PRODUCTS FROM THE WASTE SOLUTION OF IRRADIATED NUCLEAR FUELS BY MEANS OF COUNTERCURRENT ION MIGRATION. Bilal, B. A.; Schwarz, B. Translated from Radiochim. Acta; 18: No. 3, 148-150(1972). 7p. Dep. NTIS $4.00.

The study is concerned with reprocessing of the waste solution of spent nuclear fuels by means of countercurrent ion migration: it was conducted on a model mixture. The actinide elements Np, Am, and Cm, the reusable fission products (^{137}Cs, ^{90}Sr, ^{99}Tc), and the platinum elements Ru, Rh, and Pd were obtained in a relatively simple separation process. (auth)

223 (EPA-520-9-73-3-D) ENVIRONMENTAL ANALYSIS OF THE URANIUM FUEL CYCLE. Part III. Nuclear Fuel Reprocessing. (Environmental Protection Agency, Washington, D. C. (USA). Office of Radiation Programs). Oct 1973. 150p.

Topics discussed in this environmental analysis are: effluent control technology, radiological impact of a representative plant, cumulative radiological impact of the industry, and economics of health effects reduction and effluent control. Four appendices are included: spent nuclear fuel radioactivity forecasts, fuel reprocessing, radiological impact of fuel reprocessing, and economic impact analysis. (LK)

224 (ICP-1028) FIRST ELECTROLYTIC DISSOLUTION CAMPAIGN OF EBR-II FUEL AT ICPP. Bjorklund, W. J.; Offutt, G. F ; Denney, R. D. (Allied Chemical Corp.; Idaho Falls, Idaho (USA). Idaho Chemical Programs-Operations Office). Feb 1974. Contract AT(10-1)-1375. 64p. Dep. NTIS $5.45.

The first campaign using the electrolytic dissolution facility at the Idaho Chemical Processing Plant (ICPP) was completed during 1973. Several forms of EBR-II fuel containing highly enriched uranium were dissolved in nitric acid in the electric field of the dissolver. Gadolinium, as a soluble nuclear poison, was used to guarantee nuclear safety in the head end processing equipment. (auth)

ENGINEERING

Energy Conversion

225 (SLA-73-1087) ACCELERATED LIFETESTING OF THIN FILM TUNGSTEN CONTACTS FOR A MILLIWATT Si–Ge THERMOPILE. Sweet, J. N. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 45p. Dep. NTIS $5.25.

Accelerated lifetests have been performed to determine the dependence of contact lifetime on temperature for thin film W contacts sputter deposited onto one-dimensional Si–Ge thermopiles used in a radioisotopic thermoelectric generator. The results of these tests indicate that the temperature dependence of contact lifetime follows an Arrhenius relationship quite closely with an associated activation energy which is close to that reported for the initial stages of WSi_2 layer growth in thin film W–Si systems. Extrapolation of the data from the 550–725°C experimental temperature region to lower temperatures indicates that ten year operation without contact degradation is possible at temperatures below 460°C. An examination of the precision of the estimated regression indicates that the ten year temperature limit is 450°C at the 99.9% confidence level. Contact failure, as determined from contact resistance measurements, is accompanied by loss of adhesion and unbonding at the W/Si–Ge interface. (auth)

226 (TID-24818, pp 87-97) GENERATOR DESIGNS FOR SPACE APPLICATIONS BASED ON THE COLD FUEL ^{60}Co THERMIONIC GENERATOR CONCEPT. Teagan, W. P. (Thermo Electron Corp., Waltham, MA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A design study is described which investigated the feasibility of using the cold-fuel cobalt-60 thermionic generator concept for space applications. During the study the effect on generator efficiency and weight of the important design parameters, such as fuel activity, absorber thickness, insulation effectiveness, and diode arrangement, was studied. The end result of the studies was a set of preliminary generator designs of power levels of 100, 250, 500, and 2,000 watts. These designs indicate that utilizing the cold-fuel concept can result in generators of very favorable efficiencies and power-to-weight ratios using fuel forms which are readily available. In addition, the thermal decoupling of the fuel from the emitter resulting from the cold-fuel concept results in designs which minimize the thermal and fabrication problems usually associated with isotope thermionics. (auth)

227 (TID-24818, pp 256-265) ISOTOPE THERMIONIC GENERATOR FUELED WITH METALLIC ^{60}Co. Dunlay, J. B. (Thermo Electron Crop., Waltham, MA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

An experimental thermionic generator using a ^{60}Co isotope heat source is described. Details of design, fabrication, and testing are included. This generator used thermal separation between the isotope fuel and the tungsten gamma absorber attached to the thermionic emitter. As a result of this thermal separation, the ^{60}Co fuel operates at temperatures less than 400°C while the emitter operates at 1680°C. The low fuel temperature permits the use of metallic ^{60}Co, which is currently available in large quantities and at a relatively low cost. The thermal separation of the isotope heat source is achieved by using high-temperature multi-foil thermal insulation. This insulation allows maximum transmission of the gammas from the isotope fuel to the tungsten absorber but minimizes heat transfer from the absorber to the fuel. The thermionic diode, absorber, and thermal insulation are contained within a sealed housing. A static vacuum is maintained within the housing to provide a vacuum environment for the high-temperature refractory metal generator components. The ^{60}Co fuel, however, is exterior to the generator housing and operates at low temperature in air. (auth)

228 RELAXATION PHENOMENA IN AN MHD GENERATOR WITH PREIONIZER. Blom, J. H. Eindhoven, Netherlands; Technische Hogeschool (1973). 146p.

Thesis.

A theoretical and experimental study was made of relaxation processes in MHD generators. From the calculations of the relaxation process in a two-dimensional geometry the configuration of preionizers with respect to the maximum efficiency has been derived. The time-dependent behavior of discharges in preionizers and in a periodic generator segment were studied using two-dimensional time-dependent calculations. A model for the calculation of the power output and efficiency of MHD generators has been developed. To study the relaxation processes in an MHD generator with an enthalpy input of 5 MW a shock tunnel was built which delivered a plasma with the desired parameters. The experimental results are explained by means of a theoretical analysis. The increase in the electron density due to preionization was in agreement with a quasi-one-dimensional theory. The experimental efficiencies for preionization ranged from 10 to 30%. Current distributions determined from measurements with electrostatic probes and high-speed photography showed a qualitative agreement with the theoretical results. (IAA)

229 LOSS MECHANISMS IN AN MHD GENERATOR. Houben, J. W. M. A. Eindhoven, Netherlands; Technische Hogeschool (1973). 164p.

Thesis.

Loss mechanisms which reduce the efficiency and power output of nonequilibrium Faraday-type MHD generators are discussed. Particular attention is given to losses in the boundary region. The interaction of the losses is studied on the basis of an equivalent resistance model (whose development is described). Here, the losses are represented by resistances which are loads for the bulk of the MHD generator. Equations governing the processes responsible for the losses are derived and are used to calculate numerically the influence of the electrode configuration on generator performance. It is shown that rod electrodes placed in the flow perform better than flat electrodes at the wall. Experiments performed with cesium-seeded argon plasma are described, showing that voltage drops are by far the most dominant loss mechanism. The origin of the voltage drops is studied. (IAA)

230 CORRELATION METER OF PLASMA VELOCITY IN A HYDROMAGNETIC GENERATOR CHANNEL. Kudrov, A. L.; Malyuzhonok, G. P. Meas. Tech. (USSR) (Engl. Transl.); No. 10, 1463-1465(Oct 1973).

Translated from Izmer. Tekh.; 16: No. 10, 21-22(Oct 1973).

A method for determining the velocity of gas flow-based on statistical processing of the fluctuation component of voltages or currents tapped off the regular power electrodes of a hydromagnetic generator Faraday channel is discussed. A functional schematic of the circuit is given. (WHK)

231 PERFORMANCE OF A FARADAY RARE GAS ALKALI MHD GENERATOR. Brederlow, G.; Witte, K. J.; Zinko, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 12: No. 4, 481-489(Apr 1974).

The performance of the IPP rare gas alkali MHD generator was theoretically and experimentally investigated. The open-circuit Faraday voltage, the short-circuit Hall voltage, and the load characteristic were measured at different segmentation ratios s/h and various magnetic field strengths. Furthermore, the current streamline pattern in the generator duct was determined from the equipotential lines measured by means of a movable probe. From these measurements it could be concluded that the generator is practically free of any leakage currents and internal plasma short-circuits. This conclusion was further supported by the reasonably good agreement between theory and experiment regarding the current voltage characteristic of the generator. In the calculation, allowance was made for the influence of ionization instabilities, segmentation effects, and voltage drops at the electrode, but mechanisms producing leakage currents or internal plasma short-circuits were not considered. (auth)

Facilities and Equipment

Refer also to abstracts 330, 2393, 2421, 2423, and 2426.

232 (N-73-16926) ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF ROTATING, NONCAPILLARY HEAT PIPES. Final Report. Marto, P. J. (Naval Postgraduate School, Monterey, Calif. (USA)). 30 Nov 1972. 67p. (NASA-CR-130373; NPS-59-MX-72111-a). NTIS $5.50.

An approximate theoretical model is derived for laminar film condensation on the inside of a rotating, truncated cone, and is used to predict the heat transfer performance of rotating, noncapillary heat pipes for a wide variety of parametric conditions. Experimental results are presented for water, ethyl alcohol, and Freon-113 in a stainless steel heat pipe rotating to speeds of 2800 rpm. Results show that these devices can be used effectively

to transfer large quantities of heat in rotating systems. Predicted results agree to within ±20% of the experimental data. Dropwise condensation, instead of film condensation, improves heat pipe performance while the presence of noncondensible gases impairs performance. (auth)

233 (NAA-SR-2541) BLOW TUBE FOR THE SERVICE TESTING OF AIR-COOLED NUCLEAR REACTOR MATERIALS. Nuding, J. M.; McKisson, R. L. (Atomics International Div., Canoga Park, Calif. (USA)). 15 May 1958. Contract AT(11-1)-Gen-8. 19p. Dep. NTIS $3.00.

Declassified 27 Nov 1973.

A blow tube system for the service testing of ceramic materials under the conditions of operation of Pluto applications is described. The system comprises a filtered, dry air supply; a unit for controlling humidity; a unit for flow rate control; a unit for preheating air; the blow tube; and a tubular test specimen with its heater assembly. The design considerations and goals, as well as the results of pre-operational tests of each of these sub-systems are described and evaluated. It is concluded that this apparatus operates satisfactorily for sample temperatures to 1500°C, for humidities to 0.04 pounds of water per pound of dry air, and for air flow rates to 7.5 standard cubic feet per minute. (auth)

234 (SLA-73-1023) NUMERICAL SOLUTION FOR ELECTRON-BEAM-CONTROLLED CO_2 LASER PERFORMANCE. Moreno, J. B. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 59p. Dep. NTIS $6.00.

A computer program was developed to predict the performance of the electron-beam-controlled CO_2 laser. The program accomplishes this prediction in three steps. First, the quasi-steady Boltzmann equation for electrons is solved. Next, the resulting nonequilibrium electron distribution function is folded into the inelastic collision cross sections to obtain vibrational-level electron-pumping rates. Finally, the optical cavity, translational-rotational energy, and vibrational-rate equations are simultaneously solved. These three steps are repeated for each desired time increment. The program requires as inputs the electric field and current-density time histories, the cavity parameters, the initial gas temperature, pressure and composition, and tabulated collision cross sections. No adjustable constants are introduced. The time evolution of either small-signal gain or oscillator output power can be computed. These theoretical predictions are compared with recent data taken on Sandia's 10-liter cold-cathode electron-beam-controlled CO_2 laser as well as with data taken at other laboratories. Generally, the code satisfactorily predicts small-signal gain for gas mixtures containing nitrogen; the largest discrepancy is for pure CO_2. The code also predicts the shapes of oscillator pulses acceptably. (auth)

235 (UCID-16465) CHARACTERIZATION OF A NEODYMIUM GLASS ROD DAMAGED IN THE PLASMA-X LASER. Vandervoort, R. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Mar 1974. Contract W-7405-eng-48. 16p. Dep. NTIS $4.00.

A Nd glass rod was severely damaged during operation of the Plasma-X laser. The rod was manufactured by Owens–Illinois and is designated ED-2 laser glass. The nominal composition of this type of glass, in weight percent, is: SiO_2 = 66.7, Li_2O–15.0, CaO–10.2, Al_2O_3–4.7, Nd_2O_3–3.1, and CeO_2–0.5. The rod (406) was inspected by the Optics Lab before use. Size, straightness, parallelism and flatness of faces, and optical properties were all within specification. The entrance and exit surfaces were inclined at Brewsters angle to the rod axis. The rod was used in the stage 2 amplifier section of the Plasma-X laser. Normal input was 5 mJ in 50 ps. Final output was about 1 J, and back reflections from the target put 1-J pulses into the rod. Peak power density was approximately 1 GW/cm^2. The system was subjected to hundreds of pulses. Visual examination of the rod after termination of the experiment showed that both the entrance and exit faces had sustained damage. There was also some internal damage. The rod was sectioned in the optics fabrication facility as shown in Fig. 1. Analyses were made for Nd content as a function of radial and longitudinal position, crystalline impurities, and volatile impurities. Other sections were used to characterize the surface and internal damage. (auth)

236 HEAT EXCHANGERS WITH ORTHOGONAL CIRCULATION IN SMOOTH TUBES. Calculation of the Output Temperatures of the Fluids. Boissier, A. (Electricite de France, Chatou, France). Bull. Dir. Etud. Rech., Ser. B; No. 1, 45-66(1973). (In French).

Convection heat exchangers of the smooth-tube orthogonal-circulation type operating in a region of low heat flux were studied. The thermal performance of heat exchangers was determined. A method for calculating the fluid outlet temperature from the inlet conditions and exchanger performance data is presented and the method is shown to be usable for computer processing. The case of two exchangers in series in each fluid is discussed. (FR)

237 LASER ENGINEERING AND APPLICATIONS. Digest of Technical Papers. IEEE/OSA Conference Held at Washington, DC, May 30–June 1, 1973. IEEE Cat. No. 73 CHO 739-3 Laser. New York; Institute of Electrical and Electronics Engineers, Inc. (1973). 103p. (CONF-730515-(Absts.)).

The following sessions were held: (1) holographic applications, (2) short pulse generation, (3) optical-fiber transmission, (4) gas laser developments, (5) material processing, (6) environment and velocity sensing, (7) modulation and detection, (8) solid-state lasers, (9) optical radar, (10) general applications, (11) high-power gas lasers, (12) integrated optics and sources, (13) communications and propagation, (14) low power gas lasers/tunable dye lasers, (15) nonlinear optics, (16) optical data storage and processing, (17) lasers for fusion, and (18) resonators and components. (MOW)

238 POWERFUL NANOSECOND PULSES BY STABLE PASSIVE MODE-LOCKING OF TEA CO_2 LASERS. Fortin, R.; Rheault, F.; Gilbert, J.; Blanchard, M.; Lachambre, J. L. (Defense Research Establishment Valcartier, Courcelette, Quebec). Can. J. Phys.; 51: No. 4, 414-417(15 Feb 1973).

Passive mode-locking of a double-discharge TEA CO_2 laser using SF_6 as bleachable absorber has been achieved on several rot-vib transitions of the 00°1–10°0 band. Stable pulses shorter than 2 ns and having peak powers in the 100–200 MW range have been regularly obtained. The experimental conditions and operating characteristics of the laser required to achieve stability are described. (auth)

239 PARAMETRIC STUDY OF A HELICAL TEA CO_2 LASER. Girard, A.; Pepin, H.; Vallee, J. G. (Univ. of Quebec, Varennes). Can. J. Phys.; 51: No. 16, 1705-1708(15 Aug 1973).

A parametric study is presented of a helical TEA CO_2 laser. The output pulse energy, peak power, pulse shape, and beam divergence were studied as functions of the capacitance, charging voltage, and gas composition. At 50 kV, with a capacitor of 0.01 μF for each element, 3.5 MW output was obtained in a 100 ns laser pulse. (auth)

240 RESONANT CAVITIES WITH MIRRORS MADE FROM GRADED-INDEX RODS. Vanderleeden, J.C. (Bell Laboratories, Murray Hill, New Jersey 07974). J. Appl. Phys. 45: No. 1, 201-208 (Jan 1974).

We study the stability conditions for resonant cavities with spherical mirrors made from graded-index (GRIN) rods. The spherical mirror is made by putting a high-reflective (HR) coating on one of the flat ends of a GRIN rod segment. It is shown that one or two GRIN mirrors can be used to make all the usual resonator configurations. In particular, two GRIN mirrors attached to a solid-state dielectric laser rod can be substituted for curved mirrors ground on the rod ends; the ends need only be reasonably flat. We present the following experimental verification: (i) The cw operation of a resonant cavity consisting of a flat/flat Nd : YAG rod with a GRIN mirror attached to one end, and (ii) the construction and operation of an *array* of GRIN mirrors which defines several independent simultaneously oscillating resonators within a single flat/flat Nd : YAG rod. We suggest the possibility of building a compact array of many closely packed miniature resonators by cementing a large number of GRIN mirrors to the top of a 5-mm-thick N Nd : YAG disk, the bottom of which is HR coated. The disk can be diode pumped through the circumference and/or the bottom. (auth)

241 PHENOMENOLOGICAL APPROACH TO THE DESIGN OF HIGHLY TUNABLE PRESSURE-BROADENED GAS LASERS. Degnan, J.J. (NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771). J. Appl. Phys. 45: No. 1, 257-262 (Jan 1974).

Recently published measurements of the gain in continuous-wave CO_2 waveguide lasers have indicated that the small-signal gain decreases exponentially with pressure in the range beyond about 70 Torr. In the present paper, the observed dependence of the gain on pressure has been incorporated into the general theory of homogeneously broadened gas lasers to form a phenomenological model of the waveguide laser. The model is then used to generate a series of curves intended to aid in the selection of gas mixture, operating pressure, discharge length, and mirror reflectivities when tunability is the primary design goal. The operating parameters are chosen on the basis of the desired laser characteristics (bandwidth and output power) and a small number of molecular parameters. Although the discussion emphasizes CO_2 waveguide systems, the design curves are applicable to all homogeneously broadened gas lasers. It is found that, although there exists a critical pressure beyond which the laser should not be operated for reasons of efficiency, the tunability can be increased indefinitely by incorporating a longer discharge and an appropriate tunable internal etalon. (auth)

242 MODE GAIN AND JUNCTION CURRENT IN GaAs UNDER LASING CONDITIONS. Hakki, B.W. (Bell Laboratories,

Murray Hill, New Jersey 07974). J. Appl. Phys. 45: No. 1, 288-294 (Jan 1974).

Although it is known that the small-signal gain calculations are in agreement with experimental results of lowest threshold for the zero-order mode in the thick-cavity *PpnN* junction laser, the theory for lasing mode stability under large-signal conditions has not been previously investigated. In this paper, a study is given of the geometrical conditions under which the best dynamic stability is obtained for the lasing mode in a structure capable of supporting several modes. Solutions are obtained for the carrier and gain spatial profiles in the active region of an injection laser under large-signal conditions by accounting for both spontaneous and stimulated recombination. The effect of stimulated emission in a lasing mode on the gain of a nonlasing mode is calculated. It is found that, for certain positions of the *p-n* junction within the optical cavity, an increase in lasing power in the zero-order mode suppresses the gain in higher-order modes. The optimum geometry for dynamic stability of the lasing zero-order mode is obtained when the gain region is two-thirds of the waveguide thickness, consistent with the condition for lowest zero-order mode threshold. In addition, the results also show that the quasi-Fermi level in the gain region changes as a function of stimulated power in such a way as to keep its spatially "averaged" value nearly constant. However, the position of the quasi-Fermi level at the *p-n* interface increases with increased optical power, thereby leading to a finite and positive junction differential resistance. Finally, for a double-heterostructure (DH) laser the calculated internal conversion efficiency, which is the ability of the stimulated field to extract power from the junction, is shown to decrease significantly when the thickness of the active region exceeds a carrier diffusion length. (auth)

243 DEGRADATION OF A LASER MEDIUM DUE TO IONIZATION BY A LASER PULSE. Elliott, C.J. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). J. Appl. Phys. 45: No. 1, 345-349 (Jan 1974).

An important consideration in building large-volume gas amplifiers, given the pulse duration, is the maximum output intensity which the amplifying medium can support. We consider this problem in detail for CO_2 lasers to be used in laser fusion experiments. We describe a new means of computing properties of the electron distribution function using a Monte Carlo model, and compare computations by this method with a more common Laplace transform technique. The physics of the models is carefully considered, and the previously ignored effect of Penning ionization is shown to be of potential importance. The computations strongly suggest that for a 1.3-nsec pulse at 10.6 μ, using conventional pumping techniques, an intensity of 2.3×10^9 W/cm^2 results in less than a 10% energy propagation loss, and that an intensity of 3×10^9 W/cm^2 results in more than a 10% loss. (auth)

244 MODE STRUCTURE AND BEAM DIVERGENCE OF A LARGE-BORE HIGH-POWER ARGON ION LASER. Wang, C.P.; Lin, S. (Department of Applied Mechanics and Engineering Sciences and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92037). J. Appl. Phys. 45: No. 1, 350-356 (Jan 1974).

Experimental observations on the mode structure and beam divergence of a large-bore high-power argon ion laser are discussed. The gain medium, 185 cm in length and 12 mm in diameter, is capable of generating a steady-state multiline multimode laser output of more than 125 W in the blue-green. Various stable resonance cavity configurations have been investigated. Littrow prism and small aperture have also been used to obtain single-line and low-order transverse mode operations, respectively. The beam intensity profiles at two widely separated distances from the output coupling mirror are measured by scanning the beam across a small aperture affixed to a photodetector, using a rotating mirror. The two measured beam diameters are found to increase with the transverse mode volume (or output power) at a nearly constant ratio. The far-field beam divergence angle deduced from these measurements is found to vary linearly with the initial beam diameter and to be of the order of 1 mrad at the highest output power. (auth)

245 EXPERIMENTAL STUDIES OF RADIOACTIVE CONTAMINATION BY AEROSOLS. Colome, J.; Saroul, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). pp 97-106 of Seventh National Congress of the Health Physicist's Association, Marseilles; Centre National de la Recherche Scientifique (1973). (In French).

From 7th national congress on control of ionizing radiation: pollution, dosimetry, applications; Marseilles, France (16 May 1972).

Radiological hazards often arise from the dispersion of radioactive aerosols in enclosed vessels. A description is given of the methods employed to sample aerosols and the way in which their granulometric spectrum is determined: impactor, filtering on microporous membranes, and electrostatic precipitation. Optical and electron microscopy examinations can also be carried out. Aerosols produced in a vessel containing a solution in which a critical excursion had been made to occur were studied. Atomized sodium fires in a 25 m^3 vessel led to the existence of sodium oxide aerosols, i.e., 85 to 90% of these aerosols formed sediments at the bottom of the vessel and 10 to 15% of them diffused onto the walls. Sodium fire experiments in a ventilated vessel are envisaged. (FR)

Heat Transfer and Fluid Flow

Refer also to abstracts 232, 236, 330, 1832, 1836, 1843, 1854, 1968, 2076, and 2137.

246 (AECL-4752) CALCULATION OF HEAT-TRANSFER CRISIS FOR ANNULAR TWO-PHASE FLOW OF A STEAM–LIQUID MIXTURE THROUGH AN ANNULAR CHANNEL. Kirillov, P. L.; Smogalev, I. P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). Feb 1974. Translation of FEI-297. 37p. Dep. NTIS (U. S. Sales Only) $5.00.

Formulas are derived for calculating the heat transfer crisis (dryout) for steam–water flow in an annular channel for two heating conditions, e.g., with only the internal surface heated and with both surfaces heated. (LCL)

247 RADIATION-INDUCED BOILING IN SUPERHEATED WATER AND ORGANIC LIQUIDS. Bell, C. R.; Oberle, N. P.; Rohsenow, W.; Todreas, N.; Tso, C. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 53: No. 4, 458-465(Apr 1974).

A series of studies was made of bubble nucleation by fission fragments and fast neutrons. The experimental work was conducted by a liquid suspension method in a pressure chamber designed to provide for visual determination of the onset of nucleation. The minimum superheat necessary for nucleation of visible bubbles was measured in water and propylene glycol. An analytic prediction method for the superheat threshold is presented, utilizing the "thermal spike" theory of Seitz and Rayleigh's criteria for instability of a vapor jet in liquid. This method predicts that the important parameter a, equal to the ratio of the track length in which net energy must be deposited to the critical bubble radius, should equal 6.07. By this analysis, this value is independent of the type of thermal-spike-producing radiation, the type of fluid, and the system condition. The experimental data from this investigation and all other published data were examined to determine the applicable a values. This examination did not result in identification of a values consistent with the proposed prediction. Reasons for the deviation of the data from predictions are discussed, but the basis of the deviations cannot be resolved. (auth)

248 STUDIES ON CALCIUM SULFATE SCALE FORMATION IN NUCLEATE POOL BOILING AT ATMOSPHERIC PRESSURE. Islam, M. S. Toronto; Univ. of Toronto (1972). National Library of Canada, Ottawa.

Thesis (Ph. D.).

A study was made of deposition of calcium sulfate scale in nucleate pool boiling of aqueous solutions at atmospheric pressure. The solution concentrations used were 1.50 and 1.70 g $CaSO_4$/1000 g solution. The saturation temperatures for these concentrations with respect to the hemihydrate phase were 104.2°C and 99.0°C, respectively. The heat flux ranged from 10,000 to 55,000 Btu/hr, ft^2. The test elements used were thin, electrically heated strips. Photomicrographs of the deposits and motion pictures of the bubbles were used to interpret the results. (TFD)

249 IMPROVEMENTS IN TUBULAR HEAT EXCHANGERS. Hayden, O. (to United Kingdom Atomic Energy Authority). British Patent 1,336,555. 7 Nov 1973. 4p.

Reference is made to "tube-in-shell" types of heat exchangers. A problem arises in the use of such heat exchangers as steam generators in liquid-metal cooled reactors. If a leak occurs in one of the heat exchanger tubes, high-pressure water or steam issuing through the leak will react with the sodium passing through the shell to form a highly erosive jet that can cut through adjacent tubes. Although means may be provided for detection of a leaking tube and for shutdown of feedwater to the heat exchanger, this takes time and extensive damage is likely to occur. In the system described a plate is provided, penetrated by the tubes with clearance, and located so as to act as a barrier against an erosive jet from any one tube. Several alternative methods for fabrication are described. (INIS)

250 HEAT EXCHANGER. De Clercq, W. J. C. (to B. V. Neratoom). US Patent 3,799,257. 26 Mar 1974. Filed date 7 Apr 1969. 4p.

A heat exchanger with double walls to exclude reactions between the heat-exchanging media due to tube failure is described. (TFD)

251 BOILING HEAT TRANSFER TO A FREON-113 JET IMPINGING UPWARD ONTO A FLAT, HEATED SURFACE. Ruch, M. A. Dallas; Southern Methodist Univ. (1973). 114p. University Microfilms Order No. 74-4607.

Thesis (Ph.D.).

An experimental investigation was conducted on the boiling heat transfer characteristics of a liquid Freon-113 jet impinging vertically upward onto a heated test surface. This test surface was the flat end of an electrically heated, nickel-plated, 0.508 in. dia copper cylinder. Test variables were jet velocity, jet nozzle inside diameter, test surface orientation, and surface temperature. Surface temperatures ranged from 9°F below saturation to 608°F above saturation, encompassing both the nucleate and film boiling regimes. Total heat transfer and heat flux measurements were made. Incomplete coverage of the test surface by fluid was obtained for most of the experiments, and the variable heat transfer area, called the area of contact, was measured using photographic techniques. Dimensional correlations of the heat transfer and heat flux data in both nucleate and film boiling were obtained in terms of the four test variables. In nucleate boiling, the heat transfer and heat flux were found to be independent of the orientation of the test surface. The nucleate boiling heat flux was found to be also independent of the jet velocity and nozzle inside diameter, being dependent solely on the difference between the surface temperature and the saturation temperature. Modified forms of the Rohsenow pool boiling correlation were proposed as generalized correlations of jet nucleate boiling heat transfer and heat flux data. The film boiling heat flux was seen to be independent of nozzle inside diameter and test surface orientation, although these variables were found to affect the heat transfer and contact area. Generalized correlations based on dimensional analysis were postulated for jet film boiling heat transfer and heat flux data. (Diss. Abstr. Int., B)

Materials Testing

Refer also to abstracts 362, 864, and 871.

252 (CONF-720468-, pp vp Paper 1) DEVELOPMENTS IN NONDESTRUCTIVE TESTING TECHNIQUES IN REACTOR PRESSURE VESSELS. Wylie, R. D. (Southwest Research Inst., San Antonio). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The EEI-TVA research program on nondestructive testing techniques for reactor pressure vessels is to be completed in early 1972. This paper describes the results of this program up to the initiation of the field tests on the acoustic emission test facility in Idaho. The EBOR vessel was used. (12 figures) (auth)

253 (CONF-720468-, pp vp Paper 15) ACOUSTIC EMISSION MONITORING OF ONE-INCH-THICK AND SIX-INCH-THICK FLAWED TENSILE SPECIMENS. Ying, S. P. (Southwest Research Inst., San Antonio). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

In order to apply acoustic emission technology for safety inspections of nuclear reactor vessels, basic acoustic emission data have been obtained during tensile testing of heavy-section flawed steel specimens. The characteristics of the emission rate are typical of those of other highly linear elastic materials and distinguishably different from nonlinear elastic materials. It was also found that the rate of change of emission with respect to the strain depends on the test temperatures. This temperature-dependent effect can be explained by a theoretical model based on the theory of dislocations. (11 figures) (auth)

254 (CONF-720468-, pp vp Paper 25) PRELIMINARY RESULTS FROM STATIC AND DYNAMIC FRACTURE TOUGHNESS TESTS ON PRECRACKED CHARPY SPECIMENS. Stelzman, W. J.; Berggren, R. G. (Oak Ridge National Lab., TN). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The applicability of the techniques for measuring lower-bound K_{Ic} values from small compact tension specimens was extended to precracked Charpy specimens. Studies of the effects on the lower-bound toughness were made with notch sharpness, precracking stress level, fatigue crack depth, and total crack depth as parameters. Fatigue crack depth and preloading stress level were established for measuring the minimum of the lower-bound toughness. Several series of precracked Charpy specimens were tested in a slow-bend machine between −50 and 200°F. In addition to fatigue precracked specimens, Charpy specimens having sharp cracks induced by an electron beam weld pass were also tested. The toughness results from these tests compare favorably with similar results from Charpy thickness compact tension specimens. Lower-bound dynamic toughness values were also obtained by testing the precracked specimens on an instrumented Charpy machine. These values compare well with the dynamic toughness curve established from much larger specimens. The measurement of crack arrest toughness from precracked Charpy specimens which exhibits pop-in is also being attempted, but limited results are available. (10 figures) (auth)

255 KSERO-RADIOGRAFICHESKII METOD DEFEKTOSKOPII. (Xeroradiographic Method of Defectoscopy). Gorbachev, V. I. Moscow; Atomizdat (1973). 128p.

The principles of radiation defectoscopy and the factors affecting its sensitivity are examined. The physical-technical principles of xeroradiography and the current methods of electrification, development, transfer, and fixing of images are discussed. Special attention is given to the basic methods of preparing xeroradiographic plates and their electrophysical and spectral characteristics. The specific problems of xeroradiography are discussed, i.e., sub-etching, fringe effect, and factors leading to the appearance of image defects. A survey is given of current xeroradiographic apparatus and their basic technical characteristics are reported. Problems connected with the use of xeroradiography for the quality control of welds in workshop and assembly conditions are examined. The optimum regime for the control of steel and Al manufacture is given. Some areas for the use of xeroradiography in the domestic economy are indicated. (tr-auth)

256 METHODS FOR THE PERIODIC INSPECTION OF STEEL PRESSURE VESSELS FOR NUCLEAR REACTORS. Junghem, A.; Svahn, B. (Tekniska Roentgencentralen AB, Stockholm). Non-Destruct. Test. (Guildford, Engl.); 7: No. 2, 92-96(Apr 1974).

Part of the Swedish program of studies to ensure safety and to avoid loss of generating time in the nuclear power-generation industry in Sweden is explained. It describes a remote-control ultrasonic inspection system used at Oskarshamn Unit 1. The system has been since used at other Swedish reactors. (auth)

Nuclear Explosions

Refer also to abstracts 327, and 2212–2216.

257 (AD-743548) INTERACTIONS OF STRESS WAVES WITH CRACKS IN ROCK MEDIA. Final Report, January 1971–May 1972. Blatz, P. J.; Wagner, M. H. (Shock Hydrodynamics, Sherman Oaks, Calif. (USA)). May 1972. Contract HO210019. 95p. NTIS $3.00.

Two-dimensional numerical techniques have been applied to obtain solutions of problems of stress wave interactions with cracks in rock media. The SHEP code, a finite-difference Lagrangian program that incorporates a comprehensive elastic-plastic-hydrodynamic behavioral model, was utilized as the basic numerical program in this study. Significant new capabilities of the code developed during this program were (a) the treatment of antiplane shear, or out-of-plane displacement (where the motion is dependent only on the in-plane coordinates) and (b) the incorporation of a dynamic brittle fracture criterion. (auth)

258 (AD-750721) ANALYSIS OF "ASSURED DESTRUCTION". Boylan, E. S.; Brennan, D. G.; Kahn, H. (Hudson Inst., Inc., Croton-on-Hudson, N. Y. (USA)). 20 Mar 1972. 28p. (HI-1602-RR). NTIS $3.00.

The belief that the United States must retain an "assured destruction" capability, to be able to destroy some fixed percentage of Soviet citizenry and industrial capacity, even after absorbing a Soviet nuclear first strike, is the cornerstone of American strategic policy. Arguments for and against the destrability of basing U. S. strategic policy upon retention of an assured destruction capability are given. A large number of quotations are given from proponents and opponents. (auth)

259 (AD-750722) ALTERNATIVES TO ASSURED DESTRUCTION. Boylan, E. S.; Brennan, D. G.; Kahn, H. (Hudson Inst., Inc., Croton-on-Hudson, N. Y. (USA)). 20 Mar 1972. Contract DAHC15-71-C-0206. 41p. (HI-1603-RR). NTIS $3.00.

A previous paper, "An Analysis of Assured Destruction", presented arguments for and against basing U. S. strategic policy upon retention of an assured destruction capability. This paper presents a number of alternative strategic postures and presents the argu-

ments for and against each of them. As in the earlier paper, a large number of quotations from relevant sources are given. (auth)

260 (AD-765190-4) UTILITY OF TSAI'S METHOD FOR SEISMIC DISCRIMINATION. Final Technical Report, 1 July 1971–30 September 1972. Tsai, Y. B.; Shen, W. W. (Texas Instruments, Inc., Dallas (USA)). 30 Nov 1972. Contract F44620-71-C-0112. 116p. (AFOSR-TR-73-1014). NTIS $8.25.

An automatic spectral-fitting procedure based on a simple least-squares error criterion is devised for determining the source parameters of earthquakes from surface wave data. When the procedure is supplemented by the complex cepstrum technique for removing the spectral modulations due to multipath interference, results are significantly improved. Rayleigh and Love wave spectral data recorded by the VLPE network and the NORSAR long-period array for fifty-one earthquakes in the Eurasian continent are processed by this procedure. The results are discussed on a regional basis. It is found that the surface wave spectral characteristics may vary even among earthquakes located in essentially the same epicentral region. However, the variations are not random but follow certain distinct patterns. With proper data coverage the focal depths of relatively small earthquakes can be estimated within a 20-km range by employing jointly the automatic spectral-fitting procedure and the complex cepstrum technique. (auth)

261 (JAB-99-117) LOW-RISE BUILDING DAMAGE FROM LOW AMPLITUDE GROUND MOTIONS. Scholl, R. E. (Blume (John A.) and Associates Research Div., San Francisco, Calif. (USA)). Apr 1974. Contract AT(26-1)-99. 22p. Dep. NTIS $4.00.

Data on offsite low-rise building damage from underground nuclear testing at the U. S. Atomic Energy Commission's Nevada Test Site are available for seven large tests in the period from 1966 to 1970. The data, while sparse, provide an adequate sample for the investigation of motion–damage relationships. Damage in the study is statistically described in terms of the incidence of damage complaints, the incidence of buildings damaged, and damage cost. Using 5%-damped response spectrum acceleration amplitude to characterize ground motion, the plotted data fit reasonably well with previous motion–damage relationships established from the extensive data available from the 1969 RULISON underground nuclear explosion experiment conducted in western Colorado. (auth)

262 (NVO-1163-239) PREDICTION OF GROUND MOTION CHARACTERISTICS OF UNDERGROUND NUCLEAR DETONATIONS. (Environmental Research Corp., Las Vegas, Nev. (USA)). Mar 1974. Contract AT(29-2)-1163. 207p. Dep. NTIS $7.60.

State-of-the-art information required for predicting important characteristics of ground motion (peak amplitudes and spectral composition) for underground nuclear detonations is compiled in a manual-like format in one document. Information necessary for a technical understanding of the theoretical and empirical bases of ground motion predictions as well as for making ground motion predictions for an arbitrary nuclear detonation is presented. The prediction procedures developed are based on 13 years of experience by Environmental Research Corporation as the ground motion contractor to the U. S. Atomic Energy Commission's Nevada Operations Office and are designed to produce information of the type and in the format typically required by a structural engineer performing an evaluation of structural response and damage potential. Extensive references are provided to enable the interested reader to obtain additional information on specific topics of interest. (auth)

263 (PNE-G-86) PROJECT GASBUGGY, WELL TEST DATA. Volume V. May 14, 1973–November 6, 1973. (El Paso Natural Gas Co., Tex. (USA)). 1973. 210p. Dep. NTIS $13.50.

All flow and pressure build-up data collected on Project Gasbuggy from May 14, 1973 through November 6, 1973 are presented. Surface pressures shown throughout the data were measured with a dead-weight gage. Bottomhole pressures were measured with an Amerada Type Bottomhole pressure gage. Flow rates were measured by using an orifice meter. (auth)

264 (UCID-16467) IMPROVED ONE-DIMENSIONAL CALCULATIONS OF THE EFFECTS OF FOUR NUCLEAR EXPLOSIONS IN ALLUVIUM. Hearst, J. R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Mar 1974. Contract W-7405-eng-48. 18p. Dep. NTIS $4.00.

In a previous paper, early quasi-static measurements of the pressure-volume relationship and a manufactured pressure — maximum-deviatoric-stress relationship were used to calculate the effects of nuclear events in alluvium. The threshold pressure for pore collapse was either held constant or varied in layers. Recently, new measurements of pressure versus volume and versus maximum possible deviatoric stress have become available. Calculations using these data and the same treatment of threshold disagreed badly with field measurements. By permitting the threshold for pore collapse to vary with overburden (much more realistic physically) and making the unloading behavior more realistic than in the previous calculations, agreement with experiment was generally improved over the original work. This tends to confirm the idea that threshold pressure for pore collapse is an indication of the maximum overburden stress experienced by the material. (auth)

265 NEW FIELDS OF RESEARCH IN THE PHYSICS SPECIAL APPLICATIONS LABORATORY OF THE GRENOBLE RESEARCH CENTER: CONTRIBUTION TO THE APEX PROGRAM. Bull. Inform. Sci. Tech. (Paris); No. 186, 43-56(Nov 1973). (In French).

The contribution to the APEX program covers the following three topics: the formation of craters in soils (charges ranging from 5g to 386 kg of TNT were detonated and similitude laws subsequently derived between the sizes of the craters produced and the properties of the explosives and soils); the propagation of shock waves in the soil around underground nuclear explosions (it was possible to measure the shock wave velocity and the stresses occurring in the case of high deformation velocities); and heating phenomena associated with the storage of radioactive effluents in nuclear explosion chimneys (the temperature distribution was calculated as a function of time and the problem of rock melting considered). (FR)

Protective Structures and Equipment

Refer also to abstracts 301, 558, and 2221.

266 (CEA-N-1681) DETERMINATION OF THE ADDITIONAL LOAD TO WHICH THE LUNGS OF AN INDIVIDUAL WEARING BREATHING EQUIPMENT ARE EXPOSED. Chretien, L.; LeBourdonnec, Y.; Werderer, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91–Gif-sur-Yvette (France)). Dec 1973. 58p. (In French). Dep. NTIS (U. S. Sales Only) $6.00.

A knowledge of the additional load imposed on the lungs of an individual wearing breathing protection apparatus is important for the determination of what work the wearer of such equipment can be expected to carry out. The different experimental methods proposed by several research workers are described and comparisons are made. Investigations made of the behavior of the different apparatus led to the use of analogies between mechanical and electrical laws. Three types of apparatus of the Saclay Nuclear Research Center were studied using a dynamic method. These apparatus are classified in terms of the physical activity exerted by an operator working in a polluted area and the period of time during which he is exposed. (FR)

267 EXPERIENCES WITH CHARCOAL FILTER SYSTEMS INSTALLED IN SEVERAL BUILDINGS AT THE RCN SITE. Stoute, J. R. D.; Groen, G. C. H. (Stichting Reactor Centrum Nederland, Petten). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The experience with charcoal filters in the off-gas system of the HFR (pool-type research reactor), of the waste department, and of the isotope production plant owned by Philips Duphar is presented. The results of periodical tests are discussed. Tests being carried out with elemental iodine, methyl iodide, and with the gaseous effluents normally present in the ventilation ducts of the isotope production plant are presented. (GE)

268 EXPERIENCE WITH IODINE FILTERS IN THE PRODUCTION OF IODINE LABELLED COMPOUNDS ON THE CURIE SCALE. Schulze-Pillot, G. (Farbwerke Hoechst AG, Frankfurt am Main). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

During the production of iodine-labelled compounds, iodine is released in the form of pure iodine, iodide, and organic compounds. The order of activity concentration in the treated solutions used is Ci/ml and the amount of radioactive material released can be as high as 100 mCi. This may all be released instantaneously or over periods of up to one h. The work is carried out in cells from which the exhaust air passes over activated charcoal iodine filters at two levels. Under operating conditions the decontamination factor of the two-level filtering measured over a period of 24 h lies between 10^4 and 10^5. This figure is lower than expected from the retention efficiency of each individual filter. The retention efficiency as a function of the time after release of the radioactive substance was also measured. (GE)

269 RESULTS AND INFORMATION OBTAINED FROM TESTS ON IODINE FILTERS. Wilhelm, J. G.; Gerlach, K. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Results are given of laboratory tests on batches of impregnated activated charcoal under simulated accident conditions, and of in-situ tests on iodine filters equipped with charges of this activated charcoal. Some measurements showed that the rate of retention had fallen considerably due to poisoning and aging of the activated charcoal. For this reason specific tests were carried out to determine the service life of impregnated charcoal. An account is given of these tests. (GE)

270 FILTER TESTING FACILITY AT KARLSRUHE. Dillmann, H. G.; Wilhelm, J. G ; Bruederle, F. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

As part of its filter program, the GfK has constructed a facility for testing air filters and off-gas filters used in nuclear plants. The lay-out of the rig is designed in accordance with the expected off-gas and air conditions in existing and planned nuclear power stations, and the air quality in containment buildings following accidents. The temperature, pressure, and gas composition can be varied in both fresh-air and closed cycle operation. The atmospheric humidity can be adjusted between 30 and 100%, and saturated steam and superheated steam operation are also possible. The filter testing rig is fitted with all necessary auxiliary equipment such as steam generator, refrigeration machine, and water softener. The instrumentation enables temperature, pressure, differential pressure, humidity, and flow rate to be measured at several points of the circuit. The major measuring problem is the measurement of humidity. The infrared absorption of the water vapor is measured using a new specially developed device for measuring humidity in gases. Account must be taken of the pressure dependence of the reading and the measuring range over ~3 orders of magnitude. (GE)

271 IODINE FILTER TESTING IN SWEDEN. Hesboel, R.; Norman, B.; Devell, L. (Aktiebolaget Atomenergi, Studsvik, Sweden). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Charcoals and filters used for iodine removal in off-gases and ventilation ducts in nuclear power plants have been tested in a hot-cell laboratory and in-situ to investigate and check the proper behavior of installed filter systems. In normal testing procedures, only methyl iodide is used due to more critical removal properties for this compound. The need for careful installation of filters and preoperational and periodic testing is illustrated. The poisoning of charcoal by impurities in the air was studied and some results are given. (GE)

272 IODINE SORPTION PLANT TEST PROCEDURES IN THE UNITED KINGDOM. Hillary, J. J. (United Kingdom Atomic Energy Agency, Windscale, Eng.). United Kingdom of Great Britain and Northern Ireland; (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The United Kingdom approach to performance monitoring of the iodine sorption plant combines in-situ testing at full-scale with laboratory tests of the sorbent (usually impregnated charcoal) using a realistic labelled iodine compound, methyl iodine-131. Plant performance can then be evaluated under a wide variety of operational conditions difficult to achieve conveniently on the plant. Essentially, the full-scale test gives a measure of the extent to which gas may by-pass the charcoal. Laboratory testing is also important in the assessment of in-service performance of the sorbent, to check aging and possible poisoning effects. In a typical large scale test, the source is released upstream of the plant. Penetration is measured by withdrawing a proportion of the main gas flow through charcoal samplers situated in upstream and downstream locations and comparing the sampler activities. There is considerable experience in the conducting of these large scale tests with milli-curie levels of methyl iodide-131, according to well developed safety procedures. The laboratory test for iodine sorption materials is carried out with methyl iodide-131 in air at near 100% relative humidity. Performance is again measured by charcoal samplers. (GE)

273 TESTING OF IODINE FILTER SYSTEMS. Wilhelm, J. G.; Dillmann, H. G.; Gerlach, K. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The method used in the Federal Republic of Germany for testing iodine filters for nuclear plants consists of batch testing of the sorption material under normal and simulated incident conditions, and of in-situ testing of the filters after installation. In addition to this, sorption material from test filters, which are situated in a by-pass line to the filter's sorption section, are examined at appropriate intervals. The methods and equipment used in testing are described and discussed in detail. Based on the experience obtained, proposals are made concerning the extent to which filter testing will be carried out in the future. They are intended to form the background of discussions on a uniform method of testing. (GE)

274 IODINE RETENTION IN REPROCESSING PLANTS. Herre, F. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen, mbH, Leopoldshafen, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

A description is given of the iodine filtering equipment in the reprocessing plant at Karlsruhe (WAK), together with details of preliminary test results and operating experience in the two years to date. The problems of ^{131}I and ^{129}I retention in large-scale plants are mentioned. (GE)

275 IODINE TRAPPING FROM THE EXHAUST AIR OF REPROCESSING PLANTS. Furrer, J.; Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The retention behavior of ^{131}I and ^{129}I sorption material in laboratory tests with air–NO_2 mixtures as carrier gas is described. In addition, the efficiency of the material in the tank and solvent exhaust gases of a reprocessing plant is discussed. (GE)

276 BEHAVIOUR OF IODINE SORPTION MATERIALS. Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

All iodine compounds to be found in the air vented from nuclear power plants are given. The chemical reactions by means of which fission-product iodine is retained by the sorption materials are explained briefly. The importance of the main parameters affecting the layout of sorption beds, such as type and grain size of the sorption material and relative humidity and temperature of the carrier gas, is discussed with reference to experimental results. Experiences on the dependence of the retention efficiency on the concentration of elementary iodine and methyl-iodide in the air are reported. The results are given of operating time experiments on the aging and poisoning of the sorption material and measures to prolong service life are discussed. (GE)

277 BACKGROUND INFORMATION FOR USAEC REGULATORY GUIDE 1.52. Zavodoski, R. (Directorate of Licensing, Washington, DC). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The Regulatory Guide 1.52 is the first standardization guide issued by the USAEC. It is the first guide dealing with engineered safety features of filtration systems. The bases for many of the positions in the guide are derived from its dual role of standardization and filtration systems guidance. The background bases for the positions taken in the guide in terms of its dual role are discussed. (GE)

278 REGULATORY CONTROLS APPLIED TO IODINE TRAPPING PLANTS IN UK NUCLEAR INSTALLATIONS. Wright, H. A. (Dept. of Trade and Industry, London). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The principal acts which control environmental aspects of nuclear power and the government departments and regulatory agencies involved are briefly described. The requirements for iodine absorber plants and the controls applied to the design, construction, commissioning, operation, maintenance, and testing of such plants are outlined, and the role of the regulatory agencies is discussed. (GE)

279 EXPERIENCE WITH IODINE SORPTION UNITS AT MOL. Fieuw, G.; Boulenger, R. (Centre d'Etude de Nucleaire, Mol, Belgium). (1973). vp. (In French).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec. 1973).

The air in the cells where ^{131}I is produced from irradiated tellurium oxide passes through impregnated activated charcoal filters before it is released into the atmosphere. The efficiency of the filters is checked at regular intervals and the ^{131}I release

in the chimney is monitored continuously. The ventilation system has a flow rate of 400 m^3/h and the iodine concentrations upstream of the filter are of the order of 10^{-10} g × m^{-3}. The minimum retention efficiency is 95%. Checking methods and results are described and discussed. (GE)

280 UTILIZATION OF SILVERED ZEOLITES FOR IODINE TRAPPING AT HIGH TEMPERATURE. Belval, M.; Miribel, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). (1973). vp. (In French).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The problem of trapping iodine in loops at high temperatures and of the importance of studies on safety problems, has been solved by the use of 13X silver-coated molecular sieves. The tests which have been carried out on various materials are described. An economical method of trapping is the use of a 260 g/l silver-loaded 13X sieve. Its efficiency, at 400°C and a flow rate of 70 cm/s, is in the region of 10^4. A appendix describes the method of manufacturing these sieves and the various tests conducted in order to determine manufacturing standards. (GE)

Safety Engineering

Refer also to abstract 245.

281 (MRR-132) RELIABILITY OPTIMIZATION OF A SYSTEM WITH MIXED REDUNDANCIES. Misra, K. B. (Technische Univ. Muenchen, Garching (F. R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Oct 1973. 48p. Dep. NTIS (US Sales Only) $5.50.

There is an abundance of literature on reliability optimization of a system with all its constituent subsystems having either active or standby redundancies. In practice, a system, especially a nuclear system, may consist of subsystems employing different types of redundancies, e.g., active, standby, and partial. In such a case, an optimal design of the system, under some techno-economic constraints, is quite tedious. An algorithm is described, that makes the consideration of the above general case possible. The efficiency and the powerfulness of the algorithm are illustrated through examples. Although linear constraints have been considered in this report, any general nonlinear constraints can also be easily incorporated. A study leading to the recommendations to reduce the effort to a minimum, in arriving at the optimum design, is also provided. (auth)

Vacuum Engineering

Refer also to abstract 434.

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

282 (EPA-520-9-73-3-B) ENVIRONMENTAL ANALYSIS OF THE URANIUM FUEL CYCLE. Part I. Fuel Supply. (Environmental Protection Agency, Washington, D. C. (USA). Office of Radiation Programs). Oct 1973. 188p.

The following aspects of the uranium fuel cycle are considered: overview of the uranium fuel industry, uranium milling, uranium enrichment facilities, fuel fabrication and scrap recovery, and transportation. (LK)

283 (WASH-1196(74)) SURVEY OF UNITED STATES URANIUM MARKETING ACTIVITY. (USAEC Division of Production and Materials Management, Washington, D. C.). Apr 1974. 23p. Dep. NTIS $4.00.

A survey to update information relating to natural uranium sales arrangements for nuclear power plant projects was made by the Supply Evaluation Branch of the Division of Production and Materials Management. The data collected reflect the situation as of January 1, 1974. Previous surveys have been made and published each year beginning in 1968. Information was requested from, and furnished by, 64 utilities, 5 reactor manufacturers, and 20 uranium producers or companies with definite plans for future uranium production covering essentially all domestic companies involved in uranium marketing activity (Attachment A). Again, there was an excellent response from all companies contacted, assuring a virtually complete status report. Request included uranium purchase commitments, unfilled requirements, inventories, and fuel coverage. The data cover 195 civilian nuclear power reactors (privately and publicly owned) in operation, under construction or for which orders have been placed, having a total capacity of 188,000 megawatts electric (MWe). (auth)

284 COMPACT SYSTEM OF AUTOMATIC PROCESSING OF LOGGING MEASUREMENTS IN URANIUM DEPOSITS OF THE NORTH BOHEMIAN CRETACEOUS SYSTEM. Krestan, J. (Geological Survey of the Czechoslovak Uranium Industry, Hamr na Jezere). ([ndj]). vp. (In Czech).

From symposium on the mining Pribram in science and technique 1972; Pribram, Czechoslovakia (1972).

Digital recorder DKR 22 is described and its properties are listed. The recorder makes possible efficient and sufficiently accurate recordings of all logging data for shallow borings, this also without graphical representation. The system is outlined of algorithms for processing by MINSK 22 computer of the logging data obtained by DKR 11 and DKR 22. The digital recording made it possible to cut down the duration of measurements and improved the accuracy. (Nuclear Sci. Abstr. Czech.)

285 DIRECT DETERMINATION OF U AND Th BY LOGGING. Matolin, M.; Dedacek, K. (Charles Univ., Prague). ([ndj]). vp. (In Czech).

From symposium on the mining Pribram in science and technique 1972; Pribram, Czechoslovakia (1972).

The prospects of gamma spectrometry, natural selective gamma-logging, and x-ray fluorescence analysis in the determination of uranium deposit reserves are outlined. The application of the above methods should be preceded by a number of experiments. A small application depth is the common feature of the methods. The problem of direct determination of radioactive elements in rock formations can positively be solved by the development of logging by neutrons. (Nuclear Sci. Abstr. Czech.).

286 USE OF SPECIAL FILLS IN EXPLOITATION OF SEDIMENTARY URANIUM ORES IN COMPLEX HYDROGEOLOGIC CONDITIONS. Simek, P. (Czechoslovak Uranium Industry, Kamenna). ([ndj]). vp. (In Czech).

From symposium on the mining Pribram in science and technique 1972; Pribram, Czechoslovakia (1972).

Particular conditions in Czechoslovakia are discussed of sedimentary uranium ore deposit exploitation and the mining methods applied as well as the technology of filling the worked-out space using solidifying fills are reviewed. The research is dealt with in more detail into solidifying fill materials produced from power station ash. Future trends of the research are indicated and a possible rationalization of mining methods used in complex hydrogeologic conditions is contemplated. (Nuclear Sci. Abstr. Czech.)

287 MATHEMATICAL METHODS OF PLANNING THE DEVELOPMENT AND EXPLOITATION OF URANIUM ORE DEPOSITS BY HYDRAULICKING. Novak, J. (Uranium Mines, Hamr na Jezere, Czech.). ([ndj]). vp. (In Czech).

From symposium on the mining Pribram in science and technique 1972; Pribram, Czechoslovakia (1972).

In planning the development of new fields and their exploitation by hydraulicking the optimum density and the shape of drilling should be established as well as the basic regime of the exploitation, i.e. the flow and the doses of chemical reagents. The principle is discussed of formulating the criterion function for optimization calculation. A possible application is dealt with of computers and a practical computation of optimum parameters is described for the Cretaceous system in Northern Bohemia. (Nuclear Sci. Abstr. Czech.)

288 URANIUM. pp 11-13 of Aarsberaettelse 1972. Stockholm; Sveriges Geologiska Undersoekning (1973). (In Swedish).

Uranium prospecting in Sweden during 1972 is described. Radiometric measurements from aeroplanes have been done in the North and in central Sweden over a 12 500 km^2 area. Geochemical prospecting has been done regionally. Already known uranium mineralizations have been further investigated and a few new ones discovered. (SW)

289 MESTOROZHDENIYA RADIOAKTIVNYKH I REDKIKH METALLOV. (Deposits of Radioactive and Rare Earth Metals). Kotlyar, B. N.; Bayushkin, I. M.; Danchev, V. I.; Erorov, N. I.; Zheleznyak, N. N.; Kaikova, T. M.; Rafal'skii, R. P.; Strelyanov, N. P.; Terekhov, V. Ya. Moscow; Atomizdat (1973). 336p.

The geology and mineralogy of ore formations and deposits of radioactive and rare earth elements are examined. The genetic classification of U deposits is developed on the basis of formation principles. The U deposits are divided into classes of endogenic, exogenic, and metamorphogenic; the classes into genetic groups and the groups into formations and types. In the middle of post-magmatic deposits there is a series of plutogenic and volcanogenic deposits. The principal U deposits are examined. The geological locations, structure, form of the ore body and its structure, and the mineral composition and its genesis are examined. Deposits of Th, scattered elements (Cd, In, Re, Tl, Ru, Sc, Ga, Se, and Te), and rare earth deposits are considered in less detail. (tr-auth)

290 OKLO PHENOMENON. Naudet, M. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. CETAMA; No. 4, 48-51 (Nov 1973). (In French).

An anomaly in the ^{235}U content in a sample of natural uranium was discovered during a routine analysis at the UF_6 production plant at Pierrelatte. By retracing through the chain from fabrication of UF_6 to the uranium mills to the mining site, it was found that the contamination was due to the naturally occurring unusual ^{235}U content in ores from the northern extremity of the Oklo deposit in Gabon. (LCL)

Radioactive Effluents

Refer also to abstracts 210, 282, 1862, 2000, and 2189.

291 MONITORING OF LIQUID AND GASEOUS WASTES AT THE INTERUNIVERSITY REACTOR INSTITUTE. Rasmussen, C. E.; Weber, J. (Interuniversity Reactor Inst., Delft, Netherlands). pp B.10.1-B.10.3 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

Radiation monitoring activities at the Interuniversity Reactor Institute at Delft are described. These activities assure that the radioactivity of liquid and gaseous wastes released from the building does not exceed legally prescribed limits. (LCL)

Radioactivity Monitoring and Transport

Refer also to abstracts 291, 328, 1862, and 2189.

292 (SCPRI(RM)-10-1973) REPORT OF ACTIVITY, OCTOBER 1973. (Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France)). 1973. 18p. (In French). Dep. NTIS (U. S. Sales Only) $4.00.

Results concerning the surveillance of radioactivity in the environment in France are reported. Data are included on atmospheric dusts (air at ground level, high altitude air); rainwater, surface water, underground water, irrigation water, and drinking water; food chains (milk, plants, cattle, fish); and sea water around nuclear plant sites and other sites. The activities of various radioisotopes are presented in tables (^{7}Be, ^{95}Zr and ^{95}Nb, ^{103}Ru, ^{131}I, ^{137}Cs, ^{140}Ba and ^{140}La, ^{90}Sr, ^{106}Ru and ^{106}Rh, ^{226}Ra, ^{54}Mn, U and T). A monthly bibliographic selection is also presented. (FR)

293 (SCPRI(RM)-10-1973(Suppl.)) ANNEX TO MONTHLY REPORT, OCTOBER 1973. Detail of Results of Measurement. (Service Central de Protection contre les Rayonnements Ionisants, 78 - Le Vesinet (France)). 1973. 23p. (In French). Dep. NTIS (U. S. Sales Only) $4.25.

294 CAESIUM-137 AS A WATER MOVEMENT TRACER IN THE ST GEORGE'S CHANNEL. Wilson, T. R. S. (Inst. of Oceanographic Sciences, Birkenhead, Eng.). Nature (London); 248: No. 5444, 125-127(8 Mar 1974).

It is stated that study of the movement of ^{137}Cs, released into the Irish Sea as a component of the low level radioactive waste produced at the Windscale plant of British Nuclear Fuels Ltd., provides a means for the direct solution of some problems connected with the seawater movement. This nuclide is an almost ideal tracer for seawater movement as it has a long half-life, does not adsorb significantly on to sedimentary material, and is easily detected at very low concentrations. It is necessary to separate the tracer from the background activity of the seawater due to ^{40}K and to concentrate it for counting. In the experimental work described this was done by adsorbing the tracer from up to 10 litres of the water on to a small amount of Cu ferrocyanide; the Cs was essentially completely adsorbed, whereas the K was not adsorbed. Results are given for three surveys of the Irish Sea, made in 1972 to 1973. It was found that the concentration of Cs did not vary significantly with depth, over the areas investigated. It is considered that the presence of ^{137}Cs in the Irish Sea gives an opportunity to study large scale advective and diffusive processes over long time and distance scales. (UK)

Atmosphere

Refer also to abstract 337.

295 (HASL-281 and App.) FALLOUT PROGRAM. Quarterly Summary Report, December 1, 1973–March 1, 1974. Hardy, E. P. Jr. (USAEC Health and Safety Lab., New York). 1 Apr 1974. 742p. Dep. NTIS $13.60.

Current data are presented from the HASL Fallout Program and the Technical University at Wroclaw, Poland. The initial section consists of interpretive reports and notes on the termination of aircraft sampling in the stratosphere; stratospheric radioactivity from Chinese and French nuclear tests; concentrations of ^{90}Sr and ^{137}Cs in environmental samples from Poland; stratospheric radionuclide inventories; and fallout of trace metals in New York City. Subsequent sections include tabulations of radionuclide levels in fallout, surface air, stratospheric air, milk, diet, tap water, and human bone. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

296 (NRL-F-51) ENVIRONMENTAL RADIOACTIVITY. Fallout from Nuclear Weapons Tests Conducted By France in the South Pacific During July and August 1973 and Comparisons with Previous Test Series. (National Radiation Lab., Christchurch (New Zealand)). Nov 1973. 33p. Dep. NTIS (U. S. Sales Only) $4.75.

Trace levels of fresh fission products from the first nuclear test of the 1973 series were detected in mid-August in some New Zealand air filters. At about the same time slight increases in the radioactivity of weekly rain collections were measured and ^{131}I was detected at low levels in several milk samples. Fallout from the subsequent nuclear tests of the series was not detected in New Zealand. At Pacific Island stations marked increases in the radioactivity of air filters, rain samples, and increased levels of ^{131}I in milk occurred. These increases resulted mainly from westerly excursions of fission products particularly from the third and fifth explosions of the series. Fresh fission products arrived at Pacific Island stations in a matter of days after these nuclear tests. Measurements on migratory fish caught off Samoa show no contamination. By the end of October levels had fallen to pre-test levels at all stations. The levels of fallout measured and reported herein are small fractions of the reference levels and do not constitute a public health hazard. (auth)

297 (RD/B/M-2893) BEHAVIOUR OF RADIONUCLIDES IN THE ENVIRONMENT: IMPRESSIONS OF TWO RECENT INTERNATIONAL SYMPOSIA. Macdonald, H. F.; Darley, P. J.; Pepper, R. B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jan 1974. 38p. Dep. NTIS (US Sales Only) $5.00.

Personal reflections of some of the more interesting and important papers presented at two International Symposia; one on the Environmental Behaviour of Radionuclides Released in the Nuclear Industry, held in Aix-en-Provence, May 1973, and the other on the Physical Behaviour of Radioactive Contaminants in the Atmosphere, Vienna, November 1973, are discussed. Some general trends in the study of the behaviour of radionuclides in the environment are identified. (auth)

298 GAMMA-RAY EXPOSURE UNDER AN ANISOTROPICALLY DIFFUSING PLUME CONTAINING RADIOACTIVE MATERIALS. Krueger, F. W. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 16: No. 11, 347-348(Nov 1973). (In German).

The effect of anisotropic atmospheric dispersion on the gamma exposure under a radioactive plume was studied using a simple cloud model. This effect is shown to be negligible for practical conditions. (auth)

299 INVESTIGATIONS ON RADIOACTIVE FALLOUT. XI. Stierstadt, K. (Univ., Munich). Atomkernenergie; 22: No. 4, 282-284(1974). (In German).

The results of artificial beta-activity measurements during the years 1970 to 1972 are presented separately for rain and dust fallout. The accumulated activity on the earth's surface has remained almost unchanged with a nearly constant input since the beginning of 1968. (GE)

300 MONITORING OF TRITIUM IN THE ATMOSPHERE. Watanabe, T. (Nagoya Univ., Japan); Kosaka, K.; Mizuno, S. Radioisotopes (Tokyo); 22: No. 9, 514-517(Sep 1973). (In Japanese).

301 ORGANIZATION AND CO-ORDINATION OF EMERGENCY PROCEDURES IN THE EVENT OF A MAJOR NUCLEAR ACCIDENT. de Maere, X. (CEN/SCK, Mol, Belgium). pp C.4.1-C.4.4 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

The organization of emergency plans to be implemented in the case of a maximum credible accident at the Nuclear Center, Mol, is described briefly. (LCL)

302 CALCULATION AND PREDICTION OF RADIOACTIVE POLLUTION OF THE SURFACE LAYER OF THE ATMOSPHERE FROM ATOMIC POWER STATION STACK DISCHARGES. Artemova, N. E. At. Energ. (USSR); 36: No. 1, 32-38(Jan 1974). (In Russian).

Methods and results of calculating the concentration of weightless radioactive impurity entering the surface layer of the atmosphere from a continuously-active elevated source are compared. The dependence of concentration on the averaging period is discussed. Recommendations for collecting meteorological data when selecting an atomic power station site are presented. (auth)

Soil

303 (BNWL-1719) EXPERIMENTAL SUPPORT STUDIES FOR THE PERCOL AND TRANSPORT MODELS. Routson, R. C.; Serne, R. J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1972. Contract AT(45-1)-1830. 77p. Dep. NTIS $5.45.

A group of support studies conducted during development of a transport model for the Radionuclides in Soils Program is described. Measurement studies for sorption parameters concluded that: small calcium experiments are more useful than batch experiments for measuring the Kd of trace solutes which are sorbed by ion-exchange, unless the batch system is prewashed several times with influent prior to measuring the Kd; the decrease in Kd often reported with an increasing soil-to-solution ratio is the result of the reaction of the soil solid phase with the influent solution; batch and small column Kds will agree if the equilibrium chemical environment is equivalent; and the number of regression equations required to adequately define sorption in soil column work is a determinable function for each soil. The sorption of Eu was found to depend upon both ion exchange and the filtration of radiocolloids formed by solution hydrolysis in the soil. Either centrifugation or filtration was capable of removing radiocolloidal Eu from solution. Formation of radiocolloidal Eu is a predictable function of pH and solution

concentration of Ca (Ca). It is independent of the solution concentration of Na. Multiple regression analysis was used to develop regression equations for predicting Eu hydrolysis as a function of equilibrium pH and (Ca) over 3 pH ranges. Regression coefficients (r) for the 3 ranges were 0.96, 0.96, and 0.54, showing the high correlation of hydrolysis with pH and (Ca). Once radiocolloidal Eu was removed by centrifugation or filtration, Kd values could be determined for the balance of the Eu. In further study a method was developed for calculating activity coefficients for solutions with ionic strengths greater than 0.5. This method allows extension of the PERCOL[1] model to high ionic strength solutions. A method was developed to estimate the KdSr in Hanford groundwater as a function of the soil's transmissivity. Data from 5 wells were used to make a regression analysis. KdSr was found to be a linear function of the log of the permeability and the regression coefficient for the equation was found to be 0.799. Unsorbed solute was measured through soil columns using Cl^- and ^3H. The effective porosity was found to be 7.7 ± 2 percent smaller than the calculated porosity. These data were also used to calculate dispersion for the soil columns. (auth)

304 CERTAIN FEATURES IN DETERMINING THE ^{90}Sr DISCRIMINATION COEFFICIENT WITH RESPECT TO CALCIUM IN THE SOIL-PLANT SYSTEM. Ivanov, S. N.; Shaglova, E. D.; Shifrina, S. S. (Belorussian Scientific-Research Inst. of Soil Science and Agrochemistry, Minsk). Dokl. Akad. Nauk BSSR; 18: No. 1, 66-69(Jan 1974). (In Russian).

The observed ^{90}Sr discrimination coefficient in soils is expressed as the ratio of ^{90}Sr to calcium in the plant divided by the ratio of available ^{90}Sr to available calcium in the soil. If the discrimination coefficient (DC) > 1, there is discrimination of calcium with respect to ^{90}Sr. With DC < 1 there is discrimination of ^{90}Sr with respect to calcium. The DC of ^{90}Sr with respect to calcium is found as a function of the form and amount of calcium in the soil. Studies have shown that there is a clearly expressed correlation between exchangeable soil calcium and the DC value in grain culture. The DC value of ^{90}Sr with respect to calcium for lupine is related not to exchangeable calcium, but to acid-soluble calcium. Consequently the discrimination coefficient (DC) is not a constant, and depends to a significant degree on biological features of the plant. (SJR)

305 DISTRIBUTION OF NATURAL RADIOACTIVITY AND TRACE ELEMENTS IN THE SOILS AND SANDS FROM THE HIGH RADIATION COASTAL BELT OF INDIA. Kulkarni, V. V. Bombay; Bombay Univ. (1972). 128p.

Thesis.

The results of the distribution of thorium and its daughter products in soils and sands from coastal areas of India were obtained and are presented. A standard gamma spectrometric method has been developed for the quantitative estimation of gamma emitters of Th series and the applicability of this method to Th-bearing ores is discussed. Different leaching agents for the extraction of labile constituents of beach sands and soils, under controlled factors such as pH, temperature and time were studied. Suitability of various leaching agents such as neutral N ammonium acetate, 0.05 N HCl, N acetic acid, 5% EDTA, neutral normal ammonium citrate, 5% Na_2CO_3 and 5% $NaHCO_3$ for estimation of total leachable and labile elements in the soils and beach sands was studied. The investigations carried out on the physico-chemical characteristics of the soils and beach sands are discussed. Factors such as alkaline earth carbonates, base exchange capacity, loss on ignition, humus content, clay content and particle size distribution have been determined. The correlation between the humus and clay content, carbonate and clay content, base exchange capacity and labile elements has been studied. The significance and applications of the above work are discussed. The necessity of different leaching agents for different labile elements has been indicated. (auth)

306 BEHAVIOR OF RADIOACTIVE ISOTOPES IN SOILS AND THEIR ACCUMULATION BY WOOD PLANTS. Aleksakhin, R. M.; Gol'tsev, V. F.; Naryshkin, M. A.; Sirotkin, A. M. Pochvovedenie; No. 5, 51-58(May 1973). (In Russian).

The upper levels of black earth soils under birch forests are impoverished by Rb exchange in comparison with the underlying levels, but the concentration of exchanged K, Mg, Ca, and Sr is higher in the upper levels in comparison with the low-lying levels. The distribution of exchange Na in the soil profiles remains uniform. Forest litter is enriched in K with respect to Na and Rb in comparison with the upper soil levels. Twelve years after the introduction of ^{90}Sr about 5% of that in the soil is contained in non-exchanged form. With respect to accumulation by plants the alkali metals are arranged in the series K > Na > ^{137}Cs and the alkaline earth metals in the series Mg > Ca > Sr. The coefficient of accumulation of natural mixtures of Sr isotopes and ^{90}Sr 11 years after the introduction of the radionuclide in different parts of the birches is very similar. (tr-auth)

Water

307 DETERMINATION OF TRITIUM CONCENTRATION IN HOT SPRING WATERS. Ikeda, N.; Tanaka, K.; Seki, R. (Tokyo Univ. of Education). Radioisotopes (Tokyo); 22: No. 11, 623-627(Nov 1973).

Tritium concentrations in some hot spring waters and surface waters were determined. Tritium activity was measured with the liquid scintillation counter after the electrolytic enrichment. Most of the hot springs tested showed the tritium concentrations less than 10 TR, while those in the river water running in the vicinity were 70 ~ 100 TR. The low concentration of tritium in these hot spring waters suggests that they are of the rather old ground water origin. The hot springs in the Nasu district, on the other hand, showed almost the same tritium concentration as the stream waters. The origin of these spring waters, therefore, seems to be attributable to the rather fresh meteoric water. (auth)

308 URANIUM CONTENTS OF SUSPENDED MATTERS IN THE LAKES SHINJI AND NAKA-UMI, SOUTHWESTERN JAPAN. Mochizuki, T.; Nakao, S. (Geological Survey of Japan, Kanagawa). Chishitsu Chosasho Geppo; 23: No. 7, 393-398(Jul 1972). (In Japanese).

Uranium contents of the suspensions (coarser than 3.8 μ), which had been obtained through filtration from the waters (0, 2, 5 m, in water depth, and near the bottom) of the Lakes Shinji and Naka-umi, were analyzed quantitatively by the fluorescence method. Total uranium in the untreated lake waters and of the filtrates was also analyzed using the same method. Suspensions contain from 1.3 to 4.6 ppM uranium from the Shinji, and from 0.4 to 1.5 ppM from the Naka-umi, which correspond to from 0.014 to 0.050 μg/l and from 0.004 to 0.024 μg/l in the respective lake waters. Since the total uranium contents of these waters are from 0.04 to 0.07 μg/l and from 0.8 to 1.8 μg/l, they constitute from 10 to 90% and from 0 to 2% of the total uranium in these waters. The difference of the uranium contents of suspensions between these lakes is probably caused by different assemblages of the planktons considered to be the major components of the samples. (auth)

309 RADIOACTIVE MINERAL SPRINGS IN YAMANASHI PREFECTURE. Sugihara, T. (Yamanashi Univ., Kofu, Japan). Onsen Kagaku; 23: No. 2, 84-93(Oct 1972). (In Japanese).

The radium, thorium, and radon contents in Masutomi Hot Springs in Yamanashi Prefecture, measured from 1940 up to 1967, are reported. The Masutomi Hot Springs are well-known for its strong radioactivity, being ranked second in the world as radioactive hot spring group. Geological sketch of the area and present distribution of the hot springs are shown. Their temperature ranges from 6 to 40°C. Maximum values of Rn, ^{218}Po, ^{214}Pb, and ^{214}Bi seen in this report are 44770 (12300 mache), 4428, 3500 and 13600×10^{-10} Ci/l respectively, and the minimum are 7.3, 4175, 6.37 and 2.7×10^{-10} Ci/l respectively. The springing mechanism of some distinctly Rn-, Ra- or Th-rich springs in the district are explained briefly. It is concluded that radium sources are relatively shallow, and the amount of radium and its radioactive derivatives present in spring water mainly depends upon water quantity and its gushing speed. (JA)

Ecosystems and Food Cycles

310 ^{90}Sr AND ^{137}Cs INTAKE WITH MILK AND MILK PRODUCTS IN SLOVAKIA DURING 1965 TO 1971. Csupka, S. (Krajska Hygienicka Stanica, Bratislava). Lek. Obz.; 22: No. 6, 299-304(1973). (In Slovak).

The ^{90}Sr and ^{137}Cs levels in milk were studied in Slovakia during 1965 to 1971. The average values of milk activity in southern parts of Slovakia in 1971 were found to be 2.86 pCi of ^{90}Sr/gCa and 8.5 pCi of ^{137}Cs/l. In 1971, the respective levels were 57% for ^{90}Sr and 59% for ^{137}Cs of the 1965 values. In mountainous areas where precipitations are greater, the levels of both radionuclides in milk were three times higher. Thus also the intake of the radionuclides in these areas was found higher than in southern parts of Slovakia. (auth)

311 VOPROSY MORSKOI RADIOEKOLOGII. Vypusk XLIV. (Marine Radioecology. Issue 44). Pertsov, L. A. (ed.). Kaliningrad, USSR; Atlanticheskii Nauchno-Issledovatel'skii Institut Rybnogo Khozyaistva i Okeanografii (1971). 132p.

Articles are presented on current problems in marine radioecology; current and potential sources of radioactive contamination of the hydrosphere; patterns of geochemical migration of

contaminants in sea water; biogeochemical behavior of ^{234}Th in the marine environment; universal physicochemical pattern of differentiation of radioactive and stable nuclides in the ecosystem of the open ocean; dependence of accumulation of radionuclides by fish tissues on temperature and salt conditions of the medium; kinetics of ^{210}Po in fish tissue at 0°C and different water salinities; experimental data on the typical rates of removal of radionuclides from fish under different temperatures and salinities of the water; nature of the distribution of radionuclides in the bodies of fish after their transfer from contaminated to noncontaminated water; mechanism of accumulation of artificial radionuclides in seaweed; principles of predicting and evaluating radiation conditions in the neighborhood of a fishing industry; methods for fishing craft to avoid radioactive fallout; origin of natural radioactivity in the biosphere; bioindication of gamma irradiation of the sea; interpretation of instrumental gamma spectra. (MG)

312 VOPROSY MORSKOI RADIOBIOLOGII. Vypusk XLV. (Marine Radiobiology. Issue 45). Pertsov, L. A. (ed.). Kaliningrad, USSR; Atlanticheskii Nauchno-Issledovatel'skii Institut Rybnogo Khozyaistya i Okeanografii (1971). 84p.

Experimental work is reported on the following subjects: dynamics of accumulation of radionuclide fragments in industrial fish of the Baltic Sea; ^{90}Sr and ^{137}Cs in tissues of industrial fish of the Atlantic Ocean; distribution of isolated fragments and corrosive radionuclides in fish tissues; ^{90}Sr in whale teeth; ^{137}Cs content of fresh water fish with different salt conditions in the water; effect of low-grade radiation burden on the development of roe in some fish; role of water and food in the accumulation of ^{239}Pu by fresh water fish; action of ^{60}Co and ^{54}Mn radiation on trout roe; effect of ^{90}Sr on the development of roe and larvae of pike; natural radiation burden of hydrobionts; statistical studies of the ^{210}Po concentration and distribution in trout; loss of ^{210}Po by fish during cooking. (MG)

Radiometric Techniques

Refer also to abstracts 119, 284, 285, 305, 334, 426, and 2000.

313 (CEA-N-1677) THERMAL ANNEALING OF FISSION TRACKS IN MUSCOVITE MICA: GEOCHRONOLOGICAL CONSEQUENCES. Pereira de Brito, U. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France). Service d'Electronique Physique). Dec 1973. 72p. (In French). Dep. NTIS (U. S. Sales Only) $6.75.

Thesis. Submitted to Paris Univ., Orsay.

The etching kinetics of fission tracks in muscovite mica were studied in detail for different degrees of annealing. Two types of defects with well defined activation energies were revealed. The results obtained led to the development of a method for analyzing the thermometamorphism and correcting fission track ages in muscovite mica. The method could be extended to other minerals. (FR)

314 RELIABILITY AND ACCURACY OF NEUTRON–NEUTRON LOGGING FOR LITHIUM. Brem, A. A.; Krapivskii, E. I. Sal'tsevich, V. B. Ekspress-Inform., Ser.: Reg., Razved. Prom. Geofiz.; No. 1, 1-13(1973). (In Russian).

A method for the evaluation of the reliability and accuracy of neutron–neutron logging for lithium was examined. During calculation of the sensitivity threshold of the logging and of the accuracy of the determination of the Li determination in boreholes the dependence of the logging reading on the neutron properties of the ore, the construction of the hole and its surface, and the irregularity of the mineral was investigated on models and under actual conditions. The form of the curve of the logging was studied on models and under actual conditions. (tr-auth)

315 POSSIBILITY OF NEUTRON–NEUTRON ANALYSIS OF CESIUM IN BOREHOLES. Brem, A. A.; Krapivskii, E. I. Ekspress-Inform., Ser.: Reg., Razved. Prom. Geofiz.; No. 1, 13-16(1973). (In Russian).

The preliminary results of model studies on the possibility of determining Cs in boreholes by the effect of the resonant absorption of epithermal neutrons were reported. A method was examined for the elimination of the effect of interference factors on the reading of the neutron–neutron logging, based on the measurement of the ratio of the light velocity of "cesium" and "tantalum" neutrons. (tr-auth)

316 PHOTONEUTRON SAMPLING OF BERYLLIUM ORES IN SITU. Kirichenko, N. M.; Gorev, A. V.; Alyavdin, S. V. Ekspress-Inform., Ser.: Reg., Razved. Prom. Geofiz.; No. 1, 22-26(1973). (In Russian).

The application of photoneutron sampling of Be ores at one of the deposits using the Berill-3 device was described. The results of photoneutron and furrow sampling were compared. Conclusions were drawn on the feasibility of replacing geological sampling with photoneutrons. (tr-auth)

317 EFFECT OF RADIOACTIVE RADIATION ON CHEMICAL COMPOSITION OF PORE SOLUTIONS OF BOTTOMSET OCEANIC BEDS. Vovk, I. F.; Kleshchenko, S. O.; Litovshak, O. V. (Kiev State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 1, 7-10(Jan 1974). (In Ukrainian).

Experimental studies made it possible to establish that in the pore solutions of oceanic deposits hydrocarbonates magnesium, calcium and potassium sulphates as well as ammonium nitrogen are accumulated under the radiation effect. (auth)

318 PRINCIPLES OF HEALTH PHYSICS MONITORING AT C.E.N./S.C.K. Boulenger, R. (ASBL, Brussels). pp B.4.1-B.4.3 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

Monitoring activities at C.E.N., Mol, Belgium, are described and include the radiation monitoring of: liquid and gaseous effluents at the point of release; surface air, atmospheric precipitation, and milk in the environs; ^{131}I and tritium in the laboratory air; and personnel. (LCL)

319 ATMOSPHERIC CARBON DIOXIDE LEVELS AS INDICATED BY THE STABLE ISOTOPE RECORD IN WOOD. Farmer, J. G.; Baxter, M. S. (Univ. of Glasgow). Nature (London); 247: No. 5439, 273-275(1 Feb 1974).

It is stated that since direct measurements of atmospheric CO_2 are either not available or are considered unreliable. Indirect methods of assessing CO_2 build-up must be invoked. A novel and potentially valuable approach is described, based on measurement of the $^{13}C/^{12}C$ ratios of individual tree rings. Two trees were used for the studies, an oak planted in 1848 and felled in 1968, and a larch planted in 1892 and felled in 1972. If isotopic fractionation during photosynthetic assimilation of atmospheric CO_2 by growing wood has remained constant $^{13}C/^{12}C$ assay of tree rings of known age can, in theory, yield information on the past levels and isotopic composition of atmospheric CO_2. In the experimental work, in order to minimize isotopic fractionation effects, the wood samples were not subjected to any chemical treatment prior to conversion to CO_2 for isotope ratio measurement. The $^{13}C/^{12}C$ ratios were determined using a double collecting mass spectrometer, and the results showed a precision of ± 0.1 ‰ relative to a belemite limestone as primary standard, are expressed as $\delta\ ^{13}C$, the per mille deviation of sample $^{13}C/^{12}C$ from that of the standard. The results are given in detail and discussed. (UK)

320 RADIOMETRIC DETERMINATION OF P_2O_5 IN CONCRETIONARY PHOSPHORITES DURING PROSPECTING THE EGOR'EVSK DEPOSITS. Mitroshin, A. N. (All-Union Scientific-Research Inst. of Geophysics and Geochemistry, Moscow). pp 119-123 of Voprosy Yadernoi Geofiziki i Neftegazopoiskovoi Geokhimi. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

The determination of P_2O_5 in nodular phosphorites by a radiometric method was shown to be possible, using the Egor'evsk deposits as an example. The boreholes were 127 mm dia. The precision of the method was ±5%. (tr-auth)

321 ALGORITHM OF THERMAL-NEUTRON CROSS SECTION IN A STRATUM OF A CASED BOREHOLE. Tseitlin, V. G. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). pp 5-13 of Voprosy Yadernoi Geofiziki Neftegazopoiskovoi Geokhimii. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

Three methods for introducing corrections in the measured time distribution of neutrons in pulsed neutron–neutron logging, their precision, and field of application. A method is proposed which takes into account the dynamic effect of a drill hole that permits decreasing the measurement delay time. The stability of the algorithm to possible uncertainties in the initial data used for calculating the corrections was studied. (tr-auth)

322 DETERMINATION OF BAUXITES IN THE VISLOVSKI DEPOSIT BASED ON DATA FROM WELL LOGGING. Ishenko, V. I.; Leikin, A. V. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). pp 60-63 of Voprosy Yadernoi Geofiziki Neftegazopoiskovoi Geokhimii. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

In studying the distribution of Al_2O_3 in bauxites, allites, and schists of the Vislovski bauxite deposits, it was established that the efficiency of bauxite detection by the neutron activation well

logging method was 80%. Study of the covering zone for the Al_2O_3 content (37-44%) of bauxites and allites according to the iron content showed that for allites the total Fe content was no greater than 20% while for 70% bauxite the total iron content was higher than this. Thus the total efficiency of the combination of the neutron activation and gamma well logging methods for determining bauxite with the use of quantitative determinations of the Al_2O_3 and total Fe contents may be as high as 94%. (tr-auth)

323 NUCLEAR METHODS OF ANALYSIS IN BOREHOLES DRILLED FOR PROSPECTING AND DEVELOPMENT OF BAUXITE DEPOSITS OF NORTH KAZAKHSTAN. Shishakin, O. V.; Koshelev, I. P.; Taushkanov, A. P.; Shepelev, G. I.; Katorcha, G. P. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). pp 112-125 of Yaderno-Fizicheskie Metody Issledovaniya pri Razvedke i Ekhspluatatsii Mestorozhdeni Tsvetnykh, Redkikh i Ftorosoderzhashchikh Poleznykh Iskopaemykh. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

Information on the bauxite deposits of northern Kazakhstan is presented. Modifications are described for the method of activation of borehole cores from bauxite deposits with Po-Be and Po-B ampule sources and with neutron generators. Methods are presented for increasing the sensitivity. The possibility of determining the entire Fe and Ti oxide contents of bauxite by several neutron logging methods was evaluated, using different sources—^{170}Tl, ^{75}Se, ^{133}S, ^{60}Co—with two sources placed at different distances from the detector. A rational method for studying boreholes in bauxite deposits is discussed. (tr-auth)

324 NUCLEAR METHODS OF SAMPLING BOREHOLES IN PHOSPHORUS DEPOSITS. Belenko, R. D. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). pp 126-134 of Yaderno-Fizicheskie Metody Issledovaniya pri Razvedke i Ekhspluatatsii Mestorozhdeni Tsvetnykh, Redkikh i Ftorosoderzhashchikh Poleznykh Iskopaemykh. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

The determination of phosphorus from its correlation bond with fluorine was studied, based on recording the hard gamma radiation from ^{16}N formed on irradiation of fluorine-containing minerals with fast neutrons. The construction of the borehole equipment is described as well as the methods for measuring and interpreting the results. Data are presented on the effectiveness of the method on the basis of results of the study of boreholes in phosphorite and apatite deposits. (tr-auth)

325 USE OF THE GAMMA-NEUTRON METHOD IN PROSPECTING FOR RARE-METAL DEPOSITS OF A SPECIFIC MINERALIZATION. Kirichenko, N. M.; Nastich, F. E.; Muromtsev, Z. G. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). pp 34-41 of Yaderno-Fizicheskie Metody Issledovaniya pri Razvedke i Ekhspluatatsii Mestorozhdeni Tsvetnykh, Redkikh i Ftorosoderzhashchikh Poleznykh Iskopaemykh. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

Results are presented on: use of the gamma-neutron method in prospecting for rare-metal deposits of specific mineralization, characterized by an extremely non-homogeneous structure of the ores and the distribution in them of useful components; the quantitative analysis of the powdered samples in geologically documented mining production; and the finding of ore in borehole sections with selection of technological samples. In order to exclude the effect of mixing of the neutron-absorbing elements, a new method was developed for determining the self-absorption coefficient of photoneutrons ("beryllium target" method). For rapid analysis in the field, these interferences are eliminated by using a cadmium screen. Methods are described for calculation of varying moisture, density, and other parameters of the ores. Comparison of field and laboratory data of the analyses showed that the chief cause of discrepancies is non-identification of the material tested. (tr-auth)

326 GKS GAMMA-LOGGING SPECTROMETER FOR ESTIMATING THE COMMERCIAL MINERAL CONTENT IN BOREHOLES IN DEPOSITS OF NONFERROUS METALS, RARE METALS, AND FLUORITE. Vol'fshtein, P. M.; Yanshevskii, Yu. P.; Belyi, V. V.; Ochkur, A. P.; Egorov, E. V.; Sokolov, E. A. (All-Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). pp 156-178 of Yaderno-Fizicheskie Metody Issledovaniya Pri Razvedke i Ekhspluatatsii Mestorozhdeni Tsevetnykh, Redkikh i Ftorosoderzhashchikh Poleznykh Iskopaemykh. Moscow; Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Yadernoi Geofiziki i Geokhimii (1972). (In Russian).

The results of using a GKC gamma spectrometer for determining non-ferrous and rare metals and fluorites in deposits were studied. Special attention was paid to practical application of roentgenometric and neutron-gamma logging methods for determining lead, mercury, tungsten, arsenic, and barium in test boreholes. (tr-auth)

Site Surveys

Refer also to abstracts 1862 and 2069.

327 (BMI-171-153) AMCHITKA BIOENVIRONMENTAL PROGRAM. Limnology of Amchitka Island, Alaska. Final Summary Report and Progress Report, July 1, 1972-September 30, 1973. Burkett, R. D. (Battelle Columbus Labs., Ohio (USA)). Mar 1974. Contract AT(26-1)-171. 38p. Dep. NTIS $5.00.

Limnological investigations have been an integral component of Battelle's Amchitka Bioenvironmental Program since inception of the program in 1967. Initial field effort was aimed at characterizing Amchitka's aquatic ecosystems to provide baseline information necessary to identify and evaluate any perturbation to the biota and aquatic habitats resulting from the underground nuclear testing program and the support activities required for successful execution of the tests. Test-related effects were sought in terms of unnatural changes in chemical, physical, and biological attributes of the freshwater lentic and lotic environments surveyed. Changes observed in lakes following Milrow were slight, most being attributed to manifestations of seasonal fluctuation and not to Milrow results. Natural shifts in physical and chemical parameters plus changes in rates of metabolic parameters (heterotrophy and primary productivity) were not altered observably by Milrow. No elimination of planktonic species or drastic change in plankton community structure was observed. Three lakes were partially drained due to ground-surface displacement following Milrow, and one of these, Heart Lake, had gross morphological changes. Detonation of Cannikin resulted in: gross morphological changes to several lakes near SZ; rupture of a dike in a drill-mud containment pond with subsequent contamination of an adjacent creek, and formation of a new lake, Cannikin Lake, in the Cannikin subsidence crater. Cannikin Lake reached maximum size during autumn 1972 and is now the largest volumed lake on Amchitka Island. Observations of potential short-term effects to chemical and biological parameters in Amchitka lakes as a result of Cannikin were masked by the separate effects of a severe storm immediately preceding detonation, and by the effects wrought from unusually low amounts of rainfall the following spring. Longer term post-Cannikin reconnaissance has not produced evidence to indicate that any significant changes in chemical and biological parameters occurred due to the Cannikin ground shock wave. Several aquatic habitats were seriously altered as a result of drilling operations and general support activities. These waterbodies might recover their predisturbance status following evacuation of the Island. Streams perturbed by drill-mud influx appear to be recovering slowly. (auth)

328 (DOCKET-408027-11) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. AEC Draft Environmental Statement. (Kerr-McGee Corp., Oklahoma City, Okla. (USA)). 11 Apr 1974. 108p. Dep. NTIS $8.50.

A draft statement is presented on the environmental impact of constructing and operating a uranium hexafluoride manufacturing facility in Sequoyah County, Oklahoma near the confluence of the Arkansas and Illinois Rivers. The plant is designed to produce 5000 tons of uranium per year as UF_6 and has been operating since February 1960. Information is included on the site, plant, impact of site preparation and plant construction, impact of plant operation, accidents, environmental radiation monitoring program, cost-benefit analysis of environmental effects, and alternatives. (LCL)

329 (USGS-474-178) USE OF HYDROCHEMISTRY FOR INTERPRETING GROUND-WATER FLOW SYSTEMS IN CENTRAL NEVADA. Fiero, G. W. Jr.; Illian, J. R.; Dinwiddie, G. A.; Schroder, L. J. (Geological Survey, Lakewood, Colo. (USA); Nevada Univ., Reno (USA). Desert Research Inst.). Apr 1974. Contract AT(29-2)-474. 58p. Dep. NTIS $4.00.

Ground water in motion dissolves and deposits minerals in a systematic manner as it approaches chemical equilibrium with its surroundings. The validity of this general concept was confirmed in the report area by comparing the flow-system interpretation based on hydraulic data with the flow-system interpretation based on the concentration distribution of the hydrochemical species calcium, calcium plus magnesium, bicarbonate, sulfate, sodium, sodium-adsorption ratio, silica, chloride, and dissolved solids. The comparison of interpretations indicates that regional hydrochemical trends have a general relationship to regional head distribution in central Nevada. The comparison also indicates that hydrochemical conditions that are anomalous to general

trends probably reflect flow-system characteristics that are difficult to interpret on the basis of hydraulic data alone. (auth)

Thermal Effluents

Refer also to abstracts 1862, 2079, and 2080.

330 (PB-227273-0-WE) NOMOGRAPHS FOR THERMAL POLLUTION CONTROL SYSTEMS. Jedlicka, C. L. (Hittman Associates, Inc., Columbia, Md. (USA)). Sep 1973. 169p. (EPA-660-2-73-4). NTIS $3.80.

Nomographs are presented and described which permit the estimation of heat rejection system performance, tower or pond capital costs and the perturbations to power plant efficiency and costs which result from the incorporation and operation of any one of the following thermal pollution control systems within a power plant as a substitute for once-through cooling: natural draft wet towers, mechanical draft wet towers, spray ponds, cooling ponds, and natural and mechanical draft dry towers. The base case plant for cost comparisons is chosen as having a nominal turbine back pressure of 2 in. Hg absolute. The total heat rejection system with its associated costs is defined to extend outward from the turbine exhaust flange, a common boundary for each of the systems mentioned above. (NTIS)

331 THERMAL DISCHARGES FROM POWER STATIONS. Parker, F. L. (Vanderbilt Univ., Nashville). At. Energy Rev.; 11: No. 4, 793-841(Dec 1973).

All power stations, whether conventional or nuclear, require for their thermal discharges an atmospheric or hydrospheric recipient. The magnitude of the problem and its severity in comparison to other environmental stresses is shown to be slight now but could be of major significance in the future. The effect of the discharges on water quality can be severe if the temperature rise is great. The effect on aquatic organisms can be determined by evaluating the temperature and time during which the organism is under stress and the relationships of the stress to damage. Heat additions to waters or the lithosphere can be beneficial in small amounts but this use of heated discharges will not solve the waste heat problem except under highly unusual conditions. Various methods for the prediction of isotherms for rivers, reservoirs and lakes, and estuaries are explained. Formulations for the determination of mixing zones below power plants are shown. The near field (jet) and the far field (diffusion) mathematical techniques for predicting isotherms are presented. The need for physical models for prediction is discussed and the appropriate scaling ratios presented. The advantages and disadvantages of off-stream cooling, cooling ponds, spray ponds, and cooling towers are discussed. The comparative costs and environmental consequences are detailed. For each site a complete benefit/cost analyses should be made for a number of alternative modes of cooling to determine on economic, social, and environmental grounds which is the optimum system. (auth)

332 PHYSICAL AND ECOLOGICAL EFFECTS OF WASTE HEAT ON LAKE MICHIGAN. Ann Arbor, MI; Bureau of Commercial Fisheries (1970). 104p.

The potential ecological damage to Lake Michigan as the result of the discharge of industrial and municipal waste heat is evaluated. Information is included on: the existing near-shore and open-lake conditions; present and projected future thermal loading of the lake; dissipation of waste heat discharged into the lake; effects of temperature fluctuations on the spawning, incubation, and maturation of Lake Michigan fish; effects on water fowl; lake eutrophication; and general ecological ramifications of the addition of waste heat to Lake Michigan. It is concluded that: heated water discharged into Lake Michigan can affect many areal miles of the lake; cooling water requirements projected to the year 2000 would add a significant waste heat load to the beach water zone; and the projected amount of waste heat would be sufficient to impart ecological damage to the lake. For these reasons it is suggested that no significant discharge of waste heat into Lake Michigan should be permitted. (LCL)

Chemical Effluents

Refer also to abstract 1862.

333 (SLA-74-220) SANDIA LABORATORIES AIR POLLUTION SAMPLING PROGRAM. Brewer, L. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1 Apr 1974. 18p. (CONF-740406-3). Dep. NTIS $4.00.

From second AEC pollution control conference; Albuquerque, New Mexico, USA (16 Apr 1974).

The atmospheric concentrations of SO_2, NO_2, CO, total hydrocarbons and total particulate matter have been monitored inside Sandia Technical Area I for several years. The analytical results have shown the presence of these air pollutants but their concentrations have seldom exceeded the minimum control standards. (auth)

334 POLLUTION OF ENVIRONMENT AND RADIOACTIVE TRACER TECHNIQUES. Takase, A. (Inst. of Public Health, Tokyo). Nippon Koshu Eisei Zasshi; 19: No. 5, 245-249(May 1972). (In Japanese).

Radioactive tracers are used in various fields. The tracer technique is applied to the study of pollution of the environment. The absorption of SO_2 gas through the trachea and its distribution in a living body were investigated with $^{35}SO_2$ gas by using a dog. Injury in lung tissues by air pollution was studied with ^{3}H labeled thymidine. Various radioactive corpuscular tracers are used for the study of trachea removal of polluting dust. Radioactive arsenics ^{73}As, ^{74}As, ^{76}As and ^{77}As, are useful for studying the effect of arsenic. Use of ^{109}Cd is being considered. Mercury compounds labeled by ^{203}Hg are used for investigating the action of mercury. Compounds labeled by ^{35}S are useful for the measurement of distribution of ABS. Distribution of PCB is measured by using ^{3}H labeled compounds. Analysis of agricultural medicine is performed by using compounds labeled by ^{3}H, ^{14}C, ^{32}P, ^{36}Cl or ^{203}Hg. (Kato, T.)

335 TOXIC EMISSIONS IN THE ATMOSPHERE. Sigal, I. Ya.; Babenko, Yu. A. Energ. Elek.; No. 4, 6-8(1973). (In Russian).

One of the most effective ways of reducing the air pollution is to substitute gas fuel for solid or oil fuel. It has been established that after such a change is made, the emissions into the atmosphere from a municipal power plant with boiler capacity of 22 t/hr are lowered on the average by a factor of five. At power stations with energy blocks of 300 Mv this decrease is about 50%. It is recommended to consider these findings in selection of fuels for power stations. (JPRS)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 119 and 189.

General Detectors and Monitors

Refer also to abstracts 454, 455, 698, 736, 1107, 1758, 1784, 1980, 1999, 2004, and 2007.

336 (AEEW-M-996) PREDICTION OF PULSE FISSION CHAMBER INTEGRAL BIAS CURVES. Goodings, A.; Bonsor, D. R. (UKAEA Reactor Group, Winfrith, Atomic Energy Establishment). Nov 1970. 37p. Dep. NTIS (U. S. Sales Only) $5.00.

An attempt to predict the integral bias plateaus obtained from pulse fission chambers in both the charge and current output modes is described. The work has been done by considering the probable behavior of 500 possible fission events and by taking into account geometrical and amplifier gain effects. A comparison between the theoretical results and experimental data is made and shows that the technique used seems capable of predicting the ordinates of integral pulse spectra to better than a few tens of percent. Possible avenues for improvement are noted. (auth)

337 (CLOR-97) TRACK ETCH DETECTOR METHOD FOR MEASUREMENT OF RADON-222 CONCENTRATION IN AIR. Biernacka, M.; Mamont-Ciesla, K.; Wasilewski, A. (Centralne Lab. Ochrony Radiologicznej, Warsaw (Poland)). 1973. 21p. Dep. NTIS (U. S. Sales Only) $4.25.

The possibility of using cellulose triacetate detectors (Triafol TN) for measurements of ^{222}Rn concentration in air, is discussed. The features of these detectors and their calibration in the radon gas generator, are described. The results of field testing in mines are presented. (auth)

338 (INIS-mf-780, pp 47-49) IN VIVO SILICON DETECTORS AND THEIR APPLICATIONS. Friedland, S. S. (Tel Aviv Univ., Israel); Benary, V.; Ewins, J. H. Nov 1972. (In Hebrew).

From proceedings of the sixth national conference of the Israel Health Physics Society; Nahal Soeq, Israel (19 Dec 1971).

The optimum design of an in vivo nuclear semiconductor detector for medical and biological applications requires a compromise between many conflicting parameters. These include: (1) a small volume for the detector; (2) the use of a thick protective coating over the surface; (3) the use of a smooth silicon surface versus a rough surface; (4) bullet shaped construction versus plane parallel construction; and (5) design of the detector for operating at a low operating potential. The parameters of importance for an in vivo operated preamplifier are: (1) physical size, which is determined by the number and type of components; (2) temperature characteristics at body levels; (3) low power dissipation so that little heat, if any dissipated into the surrounding media; and (4) low impedance and low voltage leads from the preamplifier components which are in vivo to those components which are external. Two general forms of detectors have been developed: (1) a bullet shaped device with diameters from 3 mm to 7mm and (2) plane parallel devices of volume 1 mm^3 to surface areas of ½ cm^2 and 1 mm thick. Three forms of preamplifiers have been developed: (1) a package of 1 mm diameter and 5 mm length, (2) a package of 3 mm diameter and 5 mm length, and (2) a package of 3 mm diameter and 7 mm length. Combinations of the various detectors and preamplifiers have been made, their physical and nuclear characteristics studied, and clinical and research applications developed. (INIS)

339 (JAERI-M-5374) NONLINEAR ENERGY WEIGHTING CIRCUIT USING DISCRIMINATOR BIAS MODULATION FOR NaI(Tl) SCINTILLATION EXPOSURE-RATE METER. Moriuchi, S. (Japan Atomic Energy Research Inst., Tokyo). Aug 1973. 15p. (In Japanese). NTIS (US Sales Only).

In radiation dosimetry the radiation dose or exposure is often calculated from the measured pulse height (energy) spectrum by applying an energy weighting function dependent on the type of detector, the kind of radiation, and the radiation dose unit. Electronic circuits have been developed for calculating automatically the energy weighting, presently used in the field of health physics and in reactor shielding studies. The energy weighting circuit utilizing discriminator bias modulation is a circuit for non-linear energy weighting; it was developed for a NaI(Tl) exposure-rate meter for measurement of environmental low-level gamma exposures. The new energy weighting modules designed for easy interconnection with other standard NIM modules are considerably improved in temperature stability and overall accuracy of energy weighting, compared with the original ones. The problems in design, adjustment, and testing of the circuit are described. (auth)

340 (LF-46, pp 21-30) INSTRUMENT FOR REAL TIME DETERMINATION OF CONCENTRATIONS OF AEROSOLS OF ALPHA-EMITTING RADIONUCLIDES FOR USE IN ANIMAL INHALATION STUDIES. Light, M. E.; Hulbert, A. J.; Johnson, W. K. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972-September 30, 1973.

An aerosol concentration monitor has been designed and fabricated for the purpose of measuring aerosol concentration of α-emitting radionuclides during exposure of experimental animals. Aerosol samples are drawn at flow rates of 200 to 500 cc/min from the exposure chamber and through a filter which is separated from a diffused-junction silicon radiation detector by approximately 1 cm. The face of the detector is covered by a light tight mylar cover. Amplified pulses from the detector are routed through a discriminator so that only particles above a threshold energy are counted. The counting circuitry computes and displays accumulated activity and the rate of accumulation. (auth)

341 DETECTION OF MODULATED MOLECULAR JETS: STUDY OF THE RESPONSE AS A FUNCTION OF THE GEOMETRICAL CHARACTERISTICS OF THE DETECTOR. Genty, C.; Theobald, J. G. (Besancon Univ., France). Rev. Phys. Appl.; 8: No. 4, 361-366(Dec 1973). (In French).

The signal provided by a detector exposed to an intensity modulated jet was studied. The detector behaves as an integrator (RC circuit). The response was studied as a function of the modulation frequency. The optimum working conditions were determined from the signal-to-noise ratio curves. (FR)

342 NEW METHOD FOR STABILIZATION OF SCINTILLATION DETECTORS. Sabol, J.; Seda, J. Cesk. Cas. Fys.; 24: No. 2, 165-166(1974). (In Czech).

The proposed method is based on exploitation of a photomultiplier equipped with a control grid which makes it possible to compensate the undesirable gain fluctuations of whole scintillation detection system. (auth)

343 DIE GRENZEN DER ANWENDUNG VON SCHLECHTAUFLOESENDEN MESS-YSTEMEN ZUR ERMITTLUNG INTEGRALER UND DIFFERENTIELLER PARAMETER IN TEILCHENFELDERN. (Feasibility Limits of Measuring Systems with Poor Resolution for the Determination of Integral and Differential Parameters of Particle Fields). Schmatz, W. Munich; Technische Univ. (Feb 1972). 45p.

Thesis.

Each measuring system consists of a set of detectors whose properties are completely described by their energy-dependent sensitivity. In systems with poor resolution these sensitivity functions overlap. With the so-called pyramid concept a new criterion is proposed for the evaluation of sensitivity functions. As an example of application, the Bonner sphere spectrometer is examined by this method; the results show that the hitherto known sensitivity functions disagree with precisely performed measurements, and that the use of this spectrometer for measuring differential field parameters seems to be useful only for 1/E-like spectra. (GE)

344 APPROXIMATIONS TO THE PULSE HEIGHT DISTRIBUTION AT THE OUTPUT OF A SCINTILLATION COUNTER. Gale, H. J. (Nottingham Univ., Eng.). J. Phys., E (London); 7: No. 4, 258-260(Apr 1974).

Pearson type curves have been fitted to computed output distributions from photomultiplier tubes based on Prescott's model (Nucl. Instrum. Meth.; 39: 173-9 (1966)). It has been shown that the beta distribution derived by using the moments of the exact distribution is a good approximation to the exact distribution in all cases. The output distributions derived previously by Gale and Gibson (J. Sci. Instrum.; 43: 224-8 (1966)) have been fitted by the Pearson method and the beta distribution is found to be a better approximation than the gamma distribution then proposed. (auth)

345 ENERGY DEPENDENCE OF THE EFFICIENCY OF NEUTRON DETECTION IN POLYCARBONATE BY RECORDING ATOM RECOIL TRACKS. Jozefowicz, K. (Inst. of Nuclear Research, Swierk, Poland). pp 183-190 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Neutrons can be registered in polycarbonate foils by recording the tracks of carbon and oxygen recoil atoms from neutron elastic collisions. Estimation by calculation of the energy threshold for neutron registration resulted in a value of about 1.2 MeV. To establish experimentally the energy threshold and the efficiency of neutron detection, Makrofol E polycarbonate foils were irradiated with monoenergetic neutrons having an energy in the region of the expected detection threshold, i.e. 0.6 to 2.2 MeV, and also with 5-MeV and 14-MeV neutrons. Recoil atom tracks were revealed by etching in 6.25 N KOH or NaOH water solutions at 60°C. The track density (number of tracks per unit area) and the maximum track diameters were examined for the different neutron energies, etching solutions and etching times. The experiments resulted in series of curves showing neutron energy dependence of the maximum track diameter and the neutron detection efficiency. The minimum neutron energy needed for etchable track formation by recoil atoms is close to 0.8 MeV. KOH etching results in greater detection efficiency than NaOH etching for the same etching time. (auth)

346 CALIBRATION PROBLEMS WITH NEUTRON MODERATOR DETECTORS. Schraube, A.; Gruenauer, F.; Burger, G. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). pp 453-464 of Neutron Monitoring for Radiation Protection Purposes, Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The calibration of a moderating detector is usually performed by varying the distance between the source and the detector. Semi-empirical formulas are then used, including the source strength, constant detector responses with respect to the geometry, and several parameters fitting the readings to a $1/r^2$-law. For Bonner spheres and the long counter, measurements have been performed under special low-scatter conditions with radioisotopic sources. The main fit parameter in the distance law formula of extended moderating devices is the effective depth. It is introduced to compensate for the effect of the real change of solid angle, the effect of source anisotropy, of insufficient background corrections and, finally, of the change of the detector response itself with distance. The latter is determined by the varying distribution density of neutrons with respect to their geometry at the surface of the detector. By using calculated differential surface responses for Bonner spheres, and taking into account the other effects, the distance law for radioisotopic neutron sources was analyzed and the results compared with measurements. From the results, certain recommendations for the experimental procedure and appropriate data analysis in calibrating moderator detectors are proposed. A similar analysis was done for the long counter. (auth)

347 CALIBRATION OF THE DE PANGHER LONG COUNTER. Thompson, I. M. G.; Lavender, A. (Central Electricity Generating Board, Berkeley, Eng.). pp 465-483 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The De Pangher long counter has been widely adopted as a standard for neutron fluence measurements associated with neutron research and calibration of monitoring equipment. Calibration of the counter involves determining the counting rate per unit fluence rate as a function of neutron energy and is complicated by problems of determining the counter's effective centre and its response to room-scattered neutrons. Results of measurements made in four rooms of different sizes with an Am/Be neutron source are given. Contributions from scattered neutrons have been deduced from "shadow cone" measurements. These results illustrate the difficulties involved in using a counter in different scattering environments, a factor of importance when intercomparing measurements between laboratories. The variation in response with neutron energy in a low-scatter facility is also given. (auth)

348 CLINICAL APPRAISAL OF AN EXPERIMENTAL CONVERGING COLLIMATOR. Murphy, P. H.; Burdine, J. A.; Calderon, M. (Baylor Coll. of Medicine, Houston, TX). J. Nucl. Med.; 15: No. 4, 291-293(Apr 1974).

A description and clinical evaluation of an experimental multihole converging collimator for the scintillation camera is presented. Modulation transfer functions (MTF) relative sensitivities, phantom and clinical images were compared with those from other appropriate collimators. The collimator was judged to provide superior resolution in imaging small objects. (auth)

349 DETERMINATION OF FREQUENCY FUNCTION OF PARTICLE INTENSITY IN PULSED PHOTON BEAMS. Narita, M.; Ozawa, Y. (Hokkaido Univ., Sapporo). J. Nucl. Sci. Technol. (Tokyo); 10: No. 12, 739-745(Dec 1973).

The frequency functions of photon particle intensity were experimentally determined for bremsstrahlung produced by a 4 MeV electron linac during a pulse width of 1.6 μsec. The measurements were carried out with a plastic scintillator and electronic integrator method, making it possible to separate multiple photons that are detected during a single linac pulse. The measured distributions were compared with the Poisson distribution with the same mean value, using the chi-square test. This method can be extended to the photon energy spectrum determination. (auth)

350 ION RECOMBINATION IN IONIZATION CHAMBERS EXPOSED TO PULSED RADIATIONS. Antoku, S.; Sunayashiki, T.; Takeshita, K. (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 33: No. 9, 756-761(Sep 1973). (In Japanese).

The efficiencies of ion collection in ionization chambers exposed to pulsed radiations were measured using a Fricke dosimeter, and the results were compared with those obtained by theoretical calculation according to Boag. The collection efficiencies experimentally determined for Ionex and JAPM substandard dosimeters did not completely agree with those calculated theoretically unless an additional factor was introduced in the theoretical formula. These results were confirmed in the study of collection efficiency by varying the polarizing voltages of a JAPM dosimeter. As the charge density of pulsed radiations in medical use is generally lower than 1.0 esu · cm^{-3} per pulse, the value of 750 V · cm · esu^{-1} was appropriate in the theoretical calculations. However, it was found that this theory could not be applied to chambers of complex geometry such as the Radocon 575-602 chamber. (auth)

351 EFFECT OF MULTIPLE SCATTERING OF GAMMA-RAYS IN NaI DETECTORS ON THE CALCULATED PHOTOPEAK EFFICIENCY VALUES. Rieppo, R.; Holmberg, P. (Univ. of Oulu, Finland). Int. J. Appl. Radiat. Isotop.; 25: No. 4, 188-189(Apr 1974).

When calculating the photopeak efficiency, ϵ_{ph}, for NaI-detectors, the multiple scattering of γ-rays in the detector material must be considered and this can be achieved by using a semi-theoretical correction factor. The semi-theoretical method is demonstrated for multiple scattering in a detector. It is shown that for small γ-ray energies having dominating photo-absorption coefficients, the effect of multiple scattering is small, but as the γ-ray energy increases, Compton-scattering and pair formation become dominating, and so the semi-theoretical correction factor increases too. The measured peak-to-total ratio depends on the geometry and the detector volume, but it is almost independent of the source-to-detector distance at a defined γ-ray energy, which means that the correction factor may also be applied to extended sources. Thus we simply calculate the photopeak efficiency values, correct them for scattering effects, and arrive at ϵ_{ph}-values. (UK)

352 PORTABLE EXTERNAL TWO-CHANNEL RADIOTELEMETRICAL GM-DETECTOR UNIT, FOR MEASUREMENTS OF RADIONUCLIDE-TRACERS IN VIVO. Bojsen, J.; Vadstrup, S. (Finseninstitutet, Copenhagen). Int. J. Appl Radiat. Isotop.; 25: No. 4, 161-166(Apr 1974).

A two-channel radiotelemetrical measuring device for continuous and simultaneous detection of radionuclide tracers in vivo on humans has beed developed. The equipment is suggested for local tracer studies, when continuous long term measurements are performed. Two small end-window GM-detectors are used for detection of the tracer. High energy β-emitters such as ^{32}P are detected with high efficiency. Low energy γ-emitters like ^{125}I and ^{133}Xe can be detected with a sufficiently high efficiency. The range from the equipment to the receiving antenna is 10 to 15 m. The weight is 260 g. (auth)

353 GAS-FLOW PROPORTIONAL COUNTER FOR Na Kα × RADIATION. McHardy, W. J.; Birnie, A. U. (Macaulay Inst. for Soil Research, Aberdeen, Scotland). J. Phys., E (London); 7: No. 4, 318(Apr 1974).

Difficulty has been experienced when measuring Na Kα × radiation with the Cambridge Stereoscan S4 scanning electron microscope which uses gas-flow proportional counters as x-ray detectors. The standard counter absorbs a high proportion of sodium x rays while the low atomic number counter is very fragile and only lasts for a few spectrometer evacuations. To overcome this difficulty a system has been designed using a mesh support with a window of polycarbonate sheet 2 μm thick and since this thicker window cannot be fitted directly to the low

atomic-number counter the standard counter has been modified to take a supporting mesh. The performance of this counter has been compared with a conventional counter with a 6 μm Mylar window using the same target and beam current for each radiation and the results for Na Kα, Mg Kα, Cu Kα radiation are tabulated. A sixfold improvement has been achieved for Na Kα x rays and a smaller improvement for Mg. For atomic numbers higher than Mg little is gained by using windows thinner than 6 μm. (UK)

354 SEMICONDUCTOR GAMMA-RAY DETECTORS. Sakai, E. (Japan Atomic Energy Research Inst., Tokai). Oyo Butsuri; 42: No. 2, 97-114(Feb 1973). (In Japanese).

A previous paper (E. Sakai: Oyobuturi, Vol. 38, No. 1 (1969), pp. 2-19) described the state-of-the art in the development of semiconductor detectors at the end of 1968. The present paper reports the progress performed since 1969. The items described are as follows: status and problems in germanium crystals for manufacturing Ge(Li) detectors, the best energy resolution achieved by Ge(Li) and Si(Li) detectors, an explanation of pulse risetimes, slow pulses and their effect on the time resolution of various timing circuits for Ge(Li) detectors, the calculated and measured detection efficiency of Ge(Li) detectors, search of the appropriate standard sources for the efficiency determination, a concept of figure of merit, results of a measurement of incident gamma-ray angular dependence of the detection efficiency, temperature dependence of the performance of Ge(Li) detectors, radiation damage study, the development of gamma-cameras for medical use, ultrahigh resolution Si(Li) x-ray detectors, high-purity germanium detectors, and gamma-ray detectors made from compound-semiconductors such as GaAs, CdTe, and HgI_2. (auth)

355 MEAN SQUARE ERROR IN THE REGISTRATION OF NUCLEAR RADIATION. Kristak, J. (Slovenska Akademia Vied, Bratislava). Radioisotopy; 14: No. 3, 459-466(1973). (In Slovak).

In the determination of the statistical error of nuclear radiation registration it is generally assumed that the desintegration of a set of radioactive nuclei is described by the Poisson distribution, which leads to the mean square error $\sigma = \sqrt{n}$. It is shown that in cases where the measurement time is such that $\lambda t \geq 1$, the use of the Poissonia error is an overestimation of the error. In this case the binomial distribution leading to the mean square error $\sigma = \sqrt{ne^{-\lambda t}}$ has to be employed. The case of imperfect detection system, i.e. where the detection efficiency $\epsilon < 1$, is also discussed. (auth)

356 TRACK STRUCTURE IN PHOTOGRAPHIC EMULSION. Fowler, P. H. (Univ. of Bristol, Eng.). pp 39-51 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The lateral extent of particle tracks in nuclear emulsions is studied since nuclear emulsions have a number of features in common with multicellular living tissue. A selection of track segments of fast highly charged cosmic ray nuclei in nuclear emulsions is shown; and the measured lateral track densities are plotted as a function of the radial distance from the track for groups of heavy nuclei. Data on the track density as a function of velocity of the nuclei are plotted for $0.5 < \beta < 0.90$. The individual contributions of various atomic processes (including δ-rays, Auger electrons, and characteristic x-rays) to the deposition of energy around the path of the particle are indicated. The relevance of this study to research on ion damage in tissues is discussed. (WHK)

357 SCANNING THE RADIATION FIELD OF A 25-MeV MEDICAL BETATRON USING A NEW UNIFORMITY CHECK SYSTEM. Alvi, Z. M. (Kaiser-Permanente Medical Center, Los Angeles). Ann. Biomed. Eng.; 1: No. 1, 23-30(1972).

Radiation fields of high-energy machines can be readily scanned for beam flatness by means of a new mechanism. It is very useful in alignment of compensating filter and patient-dose uniformity checks. The scanner is carefully positioned in front of the machine in the treatment room and a remote-control console placed outside drives an upright probe and displays the relative position of the probe. The sensor in the probe consists of a semiconductor p-n junction detector made of 1-mm diameter silicon discs doped with phosphorus and boron with 0.1-mm "depletion layer" between the discs. The detector current is measured through an external circuit with very low impedance. The short-circuit current is equal to the radiation-induced current at zero bias, i.e., proportional to exposure rate. The dosimeter has an output of 33.6 pA/rad/min. Amplifiers in the console provide an output voltage which is linear with field strength up to 10 V for 500 rads/min. Console output goes into an X-Y plotter with position signal in the X axis and dose signal in the Y axis. The scanner method yields the tracings of the radiation field in about 10 min whereas alternate methods may take several hours. In addition to measuring field geometry, the scanner is useful in the studies of wedge isodose curves; dosimetry of irregular fields and radiation treatment planning for cancer patients. (auth)

358 NEUTRON ACTIVATION DETECTOR WITH A 1/v RESPONSE. Atwell, R. L. Jr. Charlottesville, VA; Univ. of Virginia (1973). 301p. University Microfilms Order No. 73-31,114.

Thesis (Ph. D.).

A neutron detector with a cross section which is inversely proportional to the incident velocity has a response which is proportional to the total neutron density, and is independent of the neutron velocity distribution. The reaction $Li^6(n,\alpha)t$ has a 1/v cross section up to a single resonance at 0.25 MeV, but the reaction products are difficult to measure unless some type of electronic counter is employed. The reaction $Li^6(n,\alpha)t$, $O^{16}(t,n)F^{18}$ yields the 112-minute positron emitter fluorine-18 which is easily detected. The use of this reaction chain for the determination of lithium or oxygen or the production of fluorine-18 has been reported by a number of workers. Values for the net fluorine-18 production cross section have been found to lie between 0.1 and 2.5 millibarns, with the most prevalent value at about 1 millibarn. The $Li^6(n,\alpha)t$, $O^{16}(t,n)F^{18}$ reaction sequence, as a 1/v neutron activation detector, was considered. A study of reactions which produce tritons, fluorine-18, positron-emitting nuclides, and gamma-emitting nuclides in suitable foil materials was carried out. Interfering activities were found to present no major problems. Foil materials were considered from the standpoint of ease of fabrication, rate of fluorine-18 production, and presence of interfering reactions. The compound lithium carbonate (Li_2CO_3) was selected as the most suitable material. Lithium carbonate foils one inch in diameter were pressed with a specially constructed set of dies and a hydraulic testing machine. It was possible to fabricate uniform foils having thicknesses of about 5 mils; for such foils the thermal neutron flux perturbation correction factor is more than 0.9. To provide for the production of fluorine-18 from tritons which leak out of thin Li_2CO_3 foils, and to increase the strength of the detector, Li_2CO_3 foils were sandwiched between two foils of silicon dioxide (SiO_2), a compound having a high oxygen content and good fabrication qualities, and which does not activate appreciably. Foils were irradiated in the reflector of the University of Virginia reactor, counted with a scintillation counter coupled to a multichannel analyzer, and the absolute activity in the 0.511-MeV photopeak was determined. The thermal flux at the irradiation position was measured to within ±7%. These results yielded a net cross section of 0.53 ± 0.05 millibarns for the production of fluorine-18 in a Li_2CO_3 foil of thickness approximately 5 mils. This cross section, when multiplied by the natural lithium concentration and the 2200 m/sec flux, gives the saturated fluorine-18 activity. The Li_2CO_3-SiO_2 sandwich foil represents a favorable optimization with respect to a number of detector parameters. (Diss. Abstr. Int., B)

359 EXPERIMENTAL SET-UP FOR THE MEASUREMENT OF PROMPT GAMMA RAYS RESULTING FROM INTERACTIONS OF 14.5 MeV NEUTRONS. Sztaricskai, T.; Baruteugli, E.; Scharbert, T.; Peto, G. (Kossuth Univ., Debrecen, Hungary). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 697-698(1972).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

360 METHODOLOGY OF POLARIZATION MEASUREMENTS. Schmidt, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 700-701(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

361 EFFI: A MONTE CARLO PROGRAM TO CALCULATE THE DETECTION EFFICIENCY OF A NEUTRON DETECTOR WITH ORGANIC SCINTILLATOR. Hermsdorf, D.; Pasieka, K. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 707-708(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

362 USE OF DIELECTRIC MATERIALS IN AUTORADIOGRAPHY. Hanzlik, J.; Machek, J.; Sedlak, A. (Vyzkumny Ustav Hygieny Zareni, Prague). Radioisotopy; 14: No. 2, 265-390 (1973). (In Czech).

The basic principles and procedures of autoradiographic techniques using dielectric foils are described. With respect to the

relatively easy quantitative evaluation of results, this method is described as a complex of seven operations resulting in radiometric interpretation of the autoradiographic finding. The work is mainly conceived as a description of working procedures with the aim to stimulate the use of autoradiography on dielectrics in experimental practice. (182 references) (auth)

363 DEVELOPMENT OF NONDESTRUCTIVE METHODS FOR MEASURING OF PLUTONIUM BY MEANS OF NEUTRON COINCIDENT TECHNIQUE. Trifonov, A.; Khristov, V.; Dragnev, T. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 191-198 (1973). (In Russian).

The characteristics are investigated by a portable device constructed for measuring the amount of plutonium in the uranium industry products. A non-destructive method based on neutron coincident technique is used. The device contains the following new elements: light water and a moderator, which makes the container portable—weight 3 kg and 30 kg during operation; possibilities for measuring samples with big capacity (up to 5 dm^3); new type detectors—corona neutron counters with helium-3 or boron-10 manifesting better characteristics in comparison with other detectors. (auth)

364 ELECTRON–PHONON DETECTOR OF IONIZING RADIATION. Kalishi, S.; Latuszek, A.; Siemienczuk, M.; Zmija, J. (Military Academy of Tech., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 22: No. 1, 65-68(1974).

The principle of an electron–phonon detector of ionizing radiation is explained and the preliminary test results are discussed. This ionizing-radiation detector operates through amplification of the acoustic wave by a drift field. The acoustic wave is produced by radiation within the amplifying region of a CdS crystal, then the wave is damped in the region of acousto-electric detection and the charge produced in that region is collected. This was verified by means of a laboratory set by applying alpha radiation emitted by Pu-239. (auth)

365 CHARACTERISTICS, PERFORMANCE, AND QUANTITATIVE ANALYTICAL CAPABILITY OF AN ENERGY-DISPERSIVE SPECTROMETER ON AN ELECTRON MICROPROBE USING LOW OPERATING VOLTAGES. Desborough, G.A.; Heidel, R.H. (United States Geological Survey, Denver, Colorado 80225). Appl. Spectrosc. 27: No. 6, 456-464 (Nov 1973).

An investigation was made of the analytical capability of a Si(Li) x-ray detector for energy-dispersive techniques in the 1- to 10-keV photon energy range with multiple single channel analyzers using the electron microprobe beam as the excitation source at operating voltages of 10 to 20 kV. This system can provide rapid, accurate, simultaneous, quantitative elemental microanalysis of major constituents in complex solids for all elements heavier than Si where spectral interferences are absent and reference standards are used. Calculated theoretical detection limits are about 0.2 wt%. A relative precision of about 1 to 5% is routine for a 10- or 20-sec counting period for elements in concentrations above about 5 wt%. Data for K, L, and M x-ray spectra of representative elements ranging in energy from 1.25 to 8.64 keV are presented for operating voltages of 10, 15, and 20 kV and beam currents of 1 to 10nA. (auth)

366 EFFECT OF SPACE CHARGES IN INSULATOR ON ACCURACY OF EMISSION DETECTOR READINGS. Assev, N. A.; Samsonov, B. V. Sov. J. At. Energy (Engl. Transl.); 34: No. 3, 245-246(Mar 1973).

Translated from At. Energ. (USSR); 34: No. 3, 194-196(Mar 1973). This is a summary of paper No. 653/6897 with full copy held at TIC.

Results from a study on the effects of temperature and exposure dose on the current from emission sensors, such as the direct-charging transducer, used for in-core neutron flux measurements are presented and discussed. (WHK)

367 COMPUTER ASSISTANCE IN GAMMA CAMERA IMAGING. Dugdale, L. M. (Alfred Hospital, Melbourne). At. Energy Aust.; 17: No. 1, 11-18(Jan 1974).

A Hewlett Packard computer interfaced with a gamma camera is used for data storage and processing in radioisotope scanning. Other applications include: (1) storage of patient data for management and library purposes; and (2) handling of data from sample counters, static probes, and bone densitometry equipment. (AT)

Radiation Dosimeters

Refer also to abstract 1759.

368 (STI/PUB-318 (Vol.2)) NEUTRON MONITORING FOR RADIATION PROTECTION PURPOSES. Volume II. Proceedings Series. Proceedings of a Symposium, Vienna, December 11–15, 1972. (International Atomic Energy Agency, Vienna (Austria)). 1973. 515p. (In Several Languages). (CONF-721203-P2). IAEA $23.00.

A separate abstract was prepared for each of the 39 papers presented at the conference. (WHK)

For abstracts of individual papers see: 345–347, 369–400, 455, 1771, 1783, and 1784.

369 MONITORING OF MIXED NEUTRON AND GAMMA RADIATION. Zielczynski, M. (Inst. of Nuclear Research, Swierk, Poland). pp 3-13 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In Russian)

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A brief review is given of methods for the dosimetric control of mixed radiation near reactors and accelerators. Mention is made of separate and combined recording of dose parameters for gamma radiation and neutrons with a limited energy spectrum. Particular attention is paid to methods for measuring the equivalent dose of mixed radiation with an arbitrary spectrum using detectors whose sensitivity depends on linear energy transfer. (45 references.) (auth)

370 DESIGN OF ALBEDO-NEUTRON DOSIMETERS. Hankins, D. E. (Los Alamos Scientific Lab., NM). pp 15-29 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Factors affecting the design of an albedo-neutron dosimetry system with ^{6}Li and ^{7}Li thermoluminescent dosimeters were studied. These factors include energy dependence, sensitivity, orientation with respect to the body, dosimeter-to-body distance, source-to-dosimeter distance, and the presence of shielding material between the source and the dosimeter. The study did not involve a specific dosimeter design, so the data obtained can be used for most albedo dosimeters. Design variables included incorporation of several thicknesses of polyethylene in the dosimeter, location of the thermal-neutron detectors at nine different positions in or on the dosimeter, and use of differing diameters and thicknesses of cadmium shields in the dosimeters. The results should enable an albedo-neutron dosimeter to be designed for a specific application or to evaluate a system already in use. The Laboratory has used the results to design three albedo-neutron dosimeters that are small and completely covered with cadmium; two containing polyethylene; and one that could be used with an automated TLD readout system. These dosimeters are designed to eliminate many of the problems that have restricted or limited the usefulness of albedo dosimeters, although it appears that the poor-energy dependence cannot be improved and may limit their widespread application. A technique has been developed to determine how variations in neutron spectra at a facility would affect the accuracy of an albedo-neutron dosimetry system before its application. This technique utilizes a 3-in. sphere and a 9-in. cadmium-loaded rem meter. It is also used to obtain the calibration factor which should be applied for a particular location or exposure. (auth)

371 LiF ALBEDO DOSIMETERS FOR PERSONNEL MONITORING IN A FAST-NEUTRON RADIATION FIELD. Piesch, E.; Burgkhardt, B. (Kernforschungszentrum, Karlsruhe, Ger.). pp 31-55 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

On the basis of albedo theory, the dose-equivalent of fast neutrons can only be measured with a sensitivity of about 1% of that for thermal neutrons. The use of albedo dosimeters for personnel monitoring was therefore limited to the measurement of neutrons in the intermediate and thermal energy ranges. An albedo dosimeter for fast-neutron personnel monitoring, the dosimeter reading of which needs no correction factor for the effect of different neutron spectra, is discussed. It consists of a pair of TLD 600 and TLD 700 ribbons, the TLD reading of which is used to separate the neutron dose and gamma dose fractions. The difference of the dosimeter readings TLD 600 and TLD 700 inside a boron capsule was found to be proportional to the dose-equivalent of neutrons. The calibration of the dosimeter was based on measurements with a rem counter and activation or threshold detectors. Phantom irradiations were performed in a radiation field of ^{252}Cf fission neutrons. $^{238}PuBe$ neutrons, 14-MeV neutrons and thermal neutrons to study the effect of moderation and scattering in the body, the floor and walls of a room, and the shieldings around the source. The albedo dosimeter system proposed for routine monitoring of personnel measures the dose-equivalent of fast neutrons with a

response which is 0.54 of that for gamma rays. The influence of source shielding, scattered radiation and direction of radiation incidence was reduced by a separate measurement of incident neutrons and albedo neutrons and was found to be within ±30% of the actual dose-equivalent in the energy range from above 100 keV to 14 MeV. (auth)

372 FAST-NEUTRON RESPONSE OF THERMOLUMINESCENT DETECTORS WITH THE PROTON RADIATOR TECHNIQUE. Sunta, C. M.; Nambi, K. S. V.; Bapat, V. N. (Bhabha Atomic Research Centre, Bombay). pp 57-61 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Little detailed study has so far been devoted to the application of thermoluminescent (TL) detectors in neutron dosimetry. This paper describes investigations of the fast neutron response of six different TL detectors: CaF_2(natural), $CaSO_4$(Mn), $CaSO_4$(Dy), $CaSO_4$(Tm), LiF TLD-100, and $Li_2B_4O_7$ (Mn). The phosphor powder is embedded in a 2-mm-thick polyethylene radiator which forms an equilibrium thickness for recoil protons resulting from incident fast neutrons of energy up to about 15 MeV. The intrinsic response of the phosphors to direct incidence of fast neutrons without a hydrogenous radiator is checked by using a Teflon holder in place of polyethylene. Glow curves are recorded for all the TL detector powders from room temperature up to 400°C after different doses of fast neutrons and gamma rays. $Li_2B_4O_7$(Mn) is found to possess the highest neutron-to-gamma sensitivity ratio and CaF_2 the lowest. In $Li_2B_4O_7$(Mn) enclosed in a polyethylene radiator, well separated new glow peaks are produced by exposure to 14-MeV neutrons at about 250° and 350°C, which may be useful for discriminating the neutron dose from the gamma dose in a mixed field. (auth)

373 SYSTEM FOR PERSONNEL DOSIMETRY IN MIXED RADIATION FIELDS. Tymons, B. J.; Tuyn, J. W. N.; Baarli, J. (CERN, Geneva). pp 63-70 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A system in which radiation-induced thermoluminescence in lithium fluoride and charged particle registration in cellulose nitrate are used has been investigated with special regard to personnel dosimetry in the environment of the CERN high-energy accelerators. A feature of this system is the fact that, while ^{6}LiF and ^{7}LiF form the basis of a conventional thermoluminescent albedo device, they may also act simultaneously as charged particle radiators for the cellulose nitrate. The LiF was investigated both in the form of teflon discs and as extruded chips (TLD 600 and 700). The cellulose nitrate consists of an 8-μm-thick layer incorporated with a red dye on a transparent polyester backing (Kodak LR 115). After a suitable etching procedure, charged particles, such as alpha particles, create visible holes in the cellulose nitrate layer. Measurements of the hole density taken under the areas both covered and not covered by the LiF provide information concerning the neutron dose. From a combination of these results it is possible to overcome some of the main disadvantages of the present personnel dosimeter. Results are given for exposures to neutrons from a PuBe source and a 14-MeV generator, and also to radiation fields around the CERN accelerators. (auth)

374 PERSONAL NEUTRON DOSIMETRY IN A PLUTONIUM PLANT. Brunskill, R. T.; Sellars, J. (British Nuclear Fuels Ltd., Seascale, Eng.). pp 71-84 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

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Routine gamma and neutron surveys with a standard gamma monitor and a neutron rem counter, which were carried out in the working areas of a plutonium plant at Windscale Works, indicated that the neutron dose rate was a significant fraction of the gamma dose rate. Neutron track films worn in the working areas invariably indicated doses considerably smaller than those estimated from neutron rem counter data. It was considered that this was due to the nature of the neutron spectra. Experimental work was initiated with a view to developing an albedo neutron dosemeter by using sachets of 'neutron-sensitive' and 'neutron-insensitive' thermoluminescent phosphors. Each type of sachet, under a range of thicknesses of cadmium filtration, was exposed on water phantoms in the principal working areas. A neutron rem counter was used to measure the neutron dose rates and this was cross-calibrated against a multi-sphere neutron spectrometer which was used as the primary standard. The measurements indicated that it was possible to design a dosemeter for routine personal issue which could be used in all working areas. Albedo dosemeters have been issued to staff employed in the plutonium plant, and results over a period greater than twelve months have now been obtained. The mean recorded neutron dose has fluctuated over this period between 20% and 80% of the mean gamma dose and there is also a clear indication that personal dosimetry is necessary, since there is a significant variation in dose between individual workers, depending on the duties they perform. (auth)

375 MEASUREMENT OF PERSONNEL NEUTRON DOSE IN REACTOR AND ASSOCIATED AREAS. Preston, H. E.; Peabody, C. O. (Atomic Energy Establishment, Winfrith, Eng.). pp 85-98 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The problems of measuring personnel neutron doses routinely at energies above thermal against a comparable level of gamma radiation are discussed. These conditions are encountered at AEE, Winfrith, in some reactor areas and also in a laboratory where fissile materials are stored and fabricated into reactor fuel capsules. The ratio of neutron-to-gamma dose varies with position and with the type of work done by individuals. The relative merits and practicability of methods such as those using personal thermoluminescent dosimeters or fission fragment track dosimeters are discussed. A thermoluminescent albedo dosimeter has been designed and adopted for general use. Its design and characteristics are discussed, together with its calibration and operational experience, acquired principally in a reactor area where the neutron dose is primarily in the energy region 0.5 eV to 1 MeV. The dosimeter incorporates lithium fluoride enriched in lithium-6 to measure the thermal neutrons reflected from the body when exposed to neutrons of higher energy and uses powder enriched in lithium-7 to measure and correct for gamma-ray exposure. The possibility of other uses and developments in design are discussed. (auth)

376 PERSONAL NEUTRON DOSIMETER, BASED ON AUTOMATIC FISSION-TRACK AND SPARK COUNTING, FOR ROUTINE AND EMERGENCY USE. Pretre, S. (Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). pp 99-115 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The improvements made to the personal neutron dosimetry system which has been in operation at the Swiss Federal Institute for Reactor Research since 1968 are described. This system is based on etched fission fragment tracks in plastics. The dosimeter, which is approximately the size of a small film badge, contains two flat detectors, one for fast neutrons ($E > 1.3$ MeV) and the other one for thermal neutrons ($E < 0.5$ eV). Each detector is composed of a sandwich arrangement of 3 foils, namely; thin polycarbonate 10 μm (Makrofol KG); fission metal (thorium or aluminium–^{235}U alloy); polycarbonate disc 0.4 mm thick (Makrofol E). The Makrofol is etched by putting it into a standard 28% KOH solution at 60°C for 30 minutes. Routine doses are obtained by counting the holes in the thin Makrofol by the spark method developed by Cross. If doses occur which are above the saturation limit of the spark counting method, fission fragment tracks are counted on the thicker Makrofol disc. This can be done automatically by using the Quantimet 720 (Image Analyzing Computer). Each detector covers at least 6 decades. The process of reading and refilling a dosimeter has been greatly rationalized, and the mean effort for the whole process has been reduced to less than 10 man-minutes/dosimeter. (auth)

377 TECHNIQUES OF SPARK COUNTING ETCHED NUCLEAR TRACKS ON PLASTIC FOILS FOR NEUTRON MONITORING. Nishiwaki, Y.; Kawai, H.; Morishima, H.; Koga, T.; Okada, Y. (Kinki Univ., Osaka). pp 117-137 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A neutron detector based on the principle of nuclear track registration in dielectric materials and consisting of a thin plastic foil placed in contact with a layer of fissile materials is described. When this unit is exposed to neutrons, the fission fragments produce tracks on the plastic foil which, after suitable chemical etching, can be counted either with an ordinary optical microscope or with an electrical sparking method. The latter method is especially suitable for rapid counting of etched tracks. The etched foil is first sandwiched between a metal electrode and an alumi-

nized foil electrode across which a voltage of 1000 to 1500 V is applied to punch unperforated etch-pits. The etched and punched detector foil is again placed on another aluminized detector foil and sparks are counted at a lower voltage of 600 to 800 V. By this method, several hundred etch pits or holes in an area of a few cm^2 can be counted in a few minutes. However, the number of counts may depend on a variety of factors of which the etching conditions, punching and counting voltage, capacitance of the sparking circuit and the pressure on the foil between the electrodes are most important. Optimum conditions for these factors must be determined with a given set of detection units to meet the required purpose. However, it should be noted that these conditions may be quite different if the thickness of the detector polycarbonate foil and the thickness of the Al electrode are different. In any case, it is extremely important to test and calibrate the detection unit carefully before its practical use for neutron monitoring. (auth)

378 TRACK DETECTORS IN THE CZECHOSLOVAK NATIONAL PERSONNEL DOSIMETRY SERVICE. Trousil, J.; Singer, J.; Marsal, J. (Inst. for Isotope Research, Production and Application, Prague). pp 139-144 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The development of track detectors for use in personnel dosimetry for neutron and radon-daughter exposures is described. The work was carried out with cellulose triacetate, polyethyleneterephthalate and mica, on which the fission fragments from natural and enriched uranium and alpha particles were registered. The track counting was done by microscope and an automatic track counting system. The results for different neutron sources and neutron fluences are presented and the possibility of practical applications in the Czechoslovak national personnel dosimetry service is discussed. (auth)

379 PROGRESS IN SOLID-STATE FAST-NEUTRON PERSONNEL DOSIMETRY. Becker, K. (Oak Ridge National Lab., TN). pp 145-158 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The poor stability of latent recoil proton tracks in photographic emulsions has frequently been underestimated due to unrealistic testing conditions. Thin polycarbonate foils to be evaluated by automatic spark counting exhibit no fading for at least three months at 32°C and 95% humidity. As one of several alternatives to the NTA film, optimized combinations containing ^{237}Np or ^{232}Th and 10 μm polycarbonate foils are described (^{237}Np covers a wide dose range of $\gtrsim 10^{-3}$ to $\lesssim 10$ rad, and neutron energies $\gtrsim 0.6$ MeV). The directional response is given for different neutron energies and detector-phantom distances. Another approach consists of the amplification of recoil nuclei etch pits to facilitate automatic counting. The inherently low fast-neutron response of most solid-state detectors can be increased by intimate contact with a hydrogenous material. TSEE detectors based on BeO, for example, which are covered with a hydrogenous radiator, have been used successfully in recent tests of criticality monitoring systems at ORNL. The thin sensitive layer of exoelectron detectors makes this approach especially attractive for intermediate neutron energies. (auth)

380 *OPERATIONAL EXPERIENCE WITH A FINGER* DOSIMETER FOR FAST NEUTRONS. Buijs, K. (European Inst. for Transuranium Elements, Karlsruhe, Ger.); Vaane, J. P.; Burgkhardt, B.; Piesch, E. pp 159-169 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

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The physical and technical characteristics, the calibration procedure and the testing in practice of a recently developed finger dosimeter for fast neutrons are discussed. For routine use the dosimeter is fitted with a single ^{232}Th fission foil, which, to detect the neutron-induced fission fragments, is in contact on one side with a 0.012-mm-thick polycarbonate foil and on the other with a 0.3-mm-thick foil of the same material. The dose from the thinner foil can be read out with a spark counter for measuring small doses up to a few rem, while the thick foil, which is read out under a microscope, is for the evaluation of higher doses. The size and shape of the detector holder are adapted to fit comfortably to the finger without causing any hindrance; special attention was paid to practical points such as robustness, comfort, and the method of changing the detectors. Space for additional detectors to obtain more detailed information on the neutron energy spectrum has been provided. A number of dosimeters were tested during work in gloveboxes. The sensitivity of the detector system was calibrated for some spontaneous fission sources as well as some (α,n) sources. (auth)

381 PERFORMANCE OF NUCLEAR TRACK EMULSION AND ALBEDO DOSEMETERS FOR MONITORING THE NEUTRON RADIATION FROM ^{252}Cf SOURCES. Knight, A. (National Radiological Protection Board, Surrey, Eng.); Marshall, T. O.; Harvey, C. L.; Harvey, J. pp 171-181 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The increasing use of ^{252}Cf spontaneous fission neutron sources in the field of radiotherapy gives rise to certain problems with regard to personal dosimetry. In the United Kingdom, two types of dosemeters are commonly used for personal neutron monitoring, the nuclear track emulsion and the albedo dosemeters. The first of these dosemeters has a lower energy threshold at about 0.5 MeV and the second has optimum sensitivity to neutrons with energies below 10 keV. Thus the nuclear track emulsion detector is probably the more suitable for use with unmoderated fission spectra, but experience in reactor environments has shown that the albedo dosemeter is more suitable for heavily moderated fission spectra. The investigation reported was conducted to determine which is the more suitable monitor for personnel using ^{252}Cf sources under conditions met in radiotherapy. The albedo dosemeter used was that designed at the C.E.G.B. Berkeley Nuclear Laboratories. The energy response of this device has been determined. The nuclear emulsion used was the Kodak Personal Neutron Monitoring Film Type A. The energy response of the Kodak Type A film was determined by using the neutron calibration facility at the National Physical Laboratory. During the investigation, both types of monitors were exposed to a source consisting of a number of ^{252}Cf needles under a series of conditions typical of those met in radiotherapy and their performances were compared. The comparison was based on dose-rate measurements with neutron rem counters. The investigation showed that, in the simulated conditions, the nuclear emulsion is inherently more suitable than the albedo dosemeter for use as a neutron personal dosemeter for staff exposed to ^{252}Cf sources. Its response to ^{252}Cf neutrons was about 30% below that for AmBe neutrons (the usual calibration source), but was nevertheless sufficiently constant for all the irradiation conditions of the investigation. It is suggested that the normal AmBe calibration factor of the nuclear emulsion should be multiplied by 1.4 when this detector is used to monitor personnel using ^{252}Cf sources. The response of the albedo dosemeter, under the same conditions, varied by a factor of about four. However, if exposure to the unshielded source is rare and can be ignored, the variation is reduced to a factor of 2 or less. This may be considered acceptable and the albedo dosemeter preferred in view of its comparative simplicity in operation. (auth)

382 PERSONNEL FAST-NEUTRON MONITORING IN POLAND. Jasiak, J.; Musialowicz, T. (Central Laboratory for Radiological Protection, Warsaw). pp 191-197 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

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Fast-neutron monitoring of personnel working in nuclear installations and with neutron sources in Poland is carried out by the Central Laboratory for Radiological Protection. The assessment of individual doses is based on measurements with Kodak Personal Neutron Monitoring Film Type A. Conversion factors of 1.56×10^4 tracks per cm^2 for PoBe neutrons and 0.75×10^4 tracks per cm^2 for 14-MeV neutrons corresponding to 1 rem were experimentally determined. An investigation was performed of track fading on films in different additional wrappings as a function of time under different climatic conditions. On the basis of the results, a correction factor equal to 1.2 was adopted, taking into account the expected track fading for one month of monitoring in the films in a given wrapping. In routine work, the dose-equivalent is calculated according to the number of tracks on a 1-mm^2 area of monitoring film and based on the calibration conversion factor for PoBe neutrons. For assessment of doses received by persons working at reactors and accelerators, the correction factor of 2 is used. The organization, methods and results of some investigations on personal fast-neutron monitoring in Poland are described. (auth)

383 PERSONAL DOSIMETER FOR MEASURING THE DOSE FROM THERMAL AND INTERMEDIATE-ENERGY NEUTRONS

AND FROM GAMMA AND BETA RADIATION. Harvey, J. R.; Hudd, W. H. R.; Townsend, S. (Central Electricity Generating Board, Berkeley, Eng.). pp 199-218 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

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The development of a personal radiation dosimeter is described. The dosimeter contains a number of sensitive elements, one of which detects neutrons from the environment which have been thermalized in the body of the wearer. This element is housed in a small plastic moulding which is loaded with boron carbide. The geometry and loading of this component were defined after a series of measurements with thermal and intermediate-energy neutrons and are such that the dosimeter has a sensitivity almost independent of neutron energy within the range thermal to 10 keV. If the dose-equivalent in this energy range is a known fraction of the total neutron dose-equivalent, the dosimeter can be used to measure dose from neutrons of all energies. Although the primary aim of the development was to produce a neutron dosimeter, the device contains a second element which is sensitive to gamma radiation and which gives a good indication of gonad dose. In addition, the design allows the use of a third, optional, element which is sensitive to soft x-rays and beta particles and gives an indication of skin dose. The dosimeter, therefore, is sensitive and accurate over a uniquely wide range of types and energies of radiation, and has some features which represent an improvement on the present film badge. In its present form, however, it is unsuitable for automatic reading. (auth)

384 NEUTRON PERSONNEL DOSIMETRY WITH FILM BADGE AND FISSION FRAGMENT TRACK DOSIMETERS. Gomaa, M. A.; Eid, A. M.; Sayed, A. M. (Atomic Energy Authority, Cairo). pp 219-225 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

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Two neutron personnel dosimeters are studied with respect to their use for routine and accident dosimetry. A film badge dosimeter is evaluated after testing the UA-RR-1 reactor experimental shield and results of experiments with a fission fragment track dosimeter at the experimental channel of the UA-RR-1 reactor are presented. For phantom geometry, the various parameters involved for proper dose-equivalent estimation are discussed. (auth)

385 DOSIMETRY OF FAST AND THERMAL NEUTRONS USING PHOTOGRAPHIC EMULSIONS. Murillo, H. (Instituto Nacional de Energia Nuclear, Mexico City). pp 227-235 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In Spanish).

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The response of two film dosimeters to thermal neutrons was studied using a 1 Ci americium-beryllium source and 10.5 cm of paraffin as moderator. A theoretical calculation of the thermal and fast neutron flux was also verified by means of reactor calculation programs (in this case "Edipo," "Prometeo" and "Islero"). (auth)

386 USE OF ^{10}B-LOADED PLASTIC IN PERSONNEL NEUTRON DOSIMETRY. Griffith, R. V. (Univ. of California, Livermore). pp 237-250 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

At the Lawrence Livermore Laboratory, various plastics loaded with enriched ^{10}B have been used as small shields for personnel dosimeters in environmental neutron monitors and for special dosimetry application. Unlike other forms of ^{10}B shielding, the borated plastic is inexpensive to fabricate, easy to handle, and can be shaped for fabricating special shields. Small discs of plastic filled with ^{10}B to a density of 1.40 g/cm^3 are now used as shields for copper and indium foils in nuclear-accident dosimeters worn by Laboratory personnel. The use of borated plastic in place of cadmium for low-energy neutron shielding increases the effective threshold for the ^{63}Cu(n,γ)^{64}Cu reaction by nearly two orders of magnitude. Also, by suppressing the low-energy activation, the copper response is more representative of the neutron flux for 0.1 keV to 1 MeV, which enhances the usefulness of copper as an accident dosimeter. The indium foil is covered with borated plastic to suppress the ^{115}In(n,γ)^{116m}In reaction. Thus, the activation of the more useful ^{115}In(n,n')^{115m}In threshold reaction can be almost immediately determined, without the long delay usually required for decay of the short-lived ^{116m}In activity. Borated plastic is also being used in the development of a TLD albedo dosimeter to reduce the low-energy neutron response of the ^{6}Li(n,α)T reaction in TLD-600. In addition to these applications, advantage has been taken of the ^{10}B(n,α)^{7}Li reaction in the plastic to locate and define low-energy neutron beams from various neutron-generating facilities. For this application, the borated material is placed against a sheet of cellulose nitrate in a neutron beam. When the cellulose nitrate is chemically etched, the pattern made by the alpha tracks accurately defines the neutron field. (auth)

387 USAEC WORKSHOP ON PERSONNEL NEUTRON DOSIMETRY. Vallario, E. J. (Atomic Energy Commission, Washington, DC); Hankins, D. E. pp 251-259 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Personnel neutron monitoring has presented special difficulties in radiological protection from the standpoints of theory and of techniques and dosimetry. The difficulties arise from the wide range of energies encountered in radiation fields as well as the shifting of energy spectrum and the effects of other radiation on dosimetry systems. In September 1969 the USAEC Division of Operational Safety convened its first Workshop of principal US investigators in the field of neutron dosimetry to focus on the problem. The discussions of three workshop meetings held to date are summarized, citing the neutron dosimetry problems associated with several source terms including the Pu processing facilities, reactor facilities and accelerators. Many of the participants have directed their efforts to the study of albedo neutron dosimeters and these are discussed along with a general review of TSEE, fission fragment damage to polycarbonates, direct fast-neutron response of TLD materials, and other potentially useful systems. The participants of the Workshop are listed indicating the type of dosimetry study within their area of interest. Also, the advantages of expanding the USA program to include international experts in this field are discussed. (auth)

388 INTERPRETATION OF MONITORING DATA FROM A PERSONNEL TLD BADGE EXPOSED TO MIXED NEUTRON AND GAMMA RADIATIONS. Boetter-Jensen, L.; Christensen, P.; Majborn, B. (Danish Atomic Energy Commission, Roskilde). pp 261-272 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

At several institutions, personnel TLD badges are used, in addition to gamma-ray dose measurement, to give some estimate of neutron dose. The interpretation of monitoring data obtained with such badges is generally complicated, due to the strong dependence of dosimeter response on neutron energy and the irradiation geometry. Thus, a knowledge of the properties and limitations of each individual badge design is essential for proper interpretation. The response of a TLD badge designed for routine personnel monitoring at Risö to mixed neutron and gamma radiations was studied. Experiments have been carried out on (1) the influence of the badge materials on dosimeter response for neutron exposures, and (2) the dependence of the response on angle of incidence and badge-to-phantom distance when the badge is attached to or positioned near the surface of an average-man phantom. Furthermore, field experiments have been carried out involving a number of persons working in a nuclear research reactor environment. On the basis of the experimental results, neutron-generated secondary radiations can be properly taken into account in the interpretation of monitoring data obtained with the TLD badge. However, as far as neutron dose estimation is concerned, the applicability of the badge is essentially restricted to known neutron energy spectra. This restriction seems to be a general limitation in the neutron-monitoring capability of personnel TLD badges. (auth)

389 NEUTRON ACTIVATION OF SODIUM IN VARIOUS PHANTOMS. Miric, I.; Ubovic, Z.; Trajkovic, M. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 273-284 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

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Blood sodium activation can be used in accident dosimetry if the neutron capture probability functions are well defined and established. The mean capture probabilities of a 136-lb man and two cylinders of 18-cm diam. and 30-cm diam., which were calculated for various intermediate- and fast-neutron spectra by

using the capture probability functions proposed by McGuire are given. For some cases, the values obtained were verified experimentally. The differences between the theoretical and experimental values agree within 20% when the capture probability is defined as neutrons captured in the body divided by neutrons entering the body. Sodium activations in BOMAB and REMCAL phantoms indicated that agreements within 20% can be expected between the theoretical and experimental activations when the capture probability values for the 30 cm cylinder are used. (auth)

390 ACTIVATION OF HUMAN BODY SODIUM IN THE NEUTRON FIELD OF THE CRAC FACILITY. Dousset, M. (CEA, Fontenay-aux-Roses, France); Ricourt, A.; Parmentier, N.; Douellou, D.; Evrard, J. pp 285-298 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In French)

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Whole-body phantoms containing sodium were exposed during several excursions of the CRAC facility for evaluating the mean neutron dose in radiation accidents. The measurements of sodium-24 activities were compared with the values calculated from neutron fluence and spectra on the basis of the results obtained by McGuire (1967) using the Monte Carlo method. Measurements and calculations are in good agreement for frontal configurations, whereas when the phantoms were exposed in profile the measured values were distinctly higher than those anticipated by calculation. The values of the absorbed dose due to secondary charged particles other than electrons at a depth of 1 cm in the body were related to the sodium-24 activity measured during frontal exposure at different points in the CRAC cell. The values obtained show variations of the order of 40% for the same value of sodium-24 activity in the body. (auth)

391 DOSIMETRY IN HIGH-INTENSITY MIXED FIELDS (NEUTRONS AND GAMMA RAYS) FOR THE PURPOSE OF EVALUATING DOSES ABSORBED IN THE HUMAN BODY. Marchal, P.; Medioni, R.; Nguyen Van Dat. (CEA, Fontenay-aux-Roses, France). pp 299-320 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In French)

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The doses absorbed in a human body during irradiation in a mixed neutron and gamma field are evaluated by measuring with adequate precision the components of the radiation field (neutron spectrum and fluence and gamma exposure) at the place where the subject is located. These components have to be measured first with operational detectors in the case of propagation in air. In the first instance, a study is made of the response of these detectors when irradiated under such conditions (set of SNAC and PS1C type activation detectors, thermoluminescent and photoluminescent detectors). When these detectors are worn by the subject his presence modifies the characteristics of the incident radiation field. The next step will therefore consist in estimating the magnitude of these perturbations in order to define more closely the margins of error inherent in the various possible methods of using the dosimeters concerned. A Plastinaut phantom is used. The exposures are performed at the CRAC source. (auth)

392 ZONAL ACTIVATION DOSIMETER. Knyazev, V. A.; Kramer-Ageev, E. A.; Martynov, Yu. N.; Troshin, V. S. (Moscow Engineering-Physics Inst.). pp 321-334 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Fast neutron spectrum measurements in the irradiation channels of the IRT-2000 reactor have shown that, in the case of the radial channels, the energy distribution depends on radiation filtration and that the space surrounding the detection point has some influence. In the light of this dependence, the authors propose using a zonal activation spectrometer for determining the neutron dose. In the zonal spectrometer, the authors have used indium, phosphorus, iron and aluminium for recording fast neutrons, indium, copper, manganese, chlorine and dysprosium for recording resonance neutrons, and copper for recording thermal neutrons. The fast neutron spectrum was calculated from the measured detector activities by a rapid method and the resonance neutron spectrum by subtracting the 1/v contribution. The error involved in deriving the neutron spectrum at arbitrarily chosen but reliable points does not exceed 15% for an induced activity measurement error of 12 to 13%. The error involved in determining the neutron dose is less than 20% for a sensitivity threshold estimated at 15 rad. The error decreases with increasing dose. The time needed for measuring the detector activity and calculating the spectrum and dose does not exceed 21 to 24 hours including exposure time. A thermoluminescent glass dosimeter (IKS-A) is used for recording the gamma radiation. (auth)

393 COMPARISON OF VARIOUS NEUTRON PERSONNEL DOSIMETERS. Krishnamoorthy, P. N.; Venkataraman, G.; Singh, D.; Dayashankar. (Bhabha Atomic Research Centre, Trombay, India). pp 343-362 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The current status of developments in the field of personnel monitoring for neutrons both under normal conditions and in accident situations is reviewed. The various systems available have been compared from the standpoints of ease of use, sophistication of ancillary devices needed, sensitivity, and accuracy. For thermal neutrons the conventional personnel monitoring film covered by cadmium filters still remains the most suitable device. Similarly, for routine fast-neutron monitoring the nuclear track emulsion still remains the most satisfactory device. The intermediate energy region continues to pose problems although these have been partially solved by albedo dosimeters employing nuclear track emulsions or thermoluminescent materials. In the field of accident monitoring some of the more recent attempts to use pairs of threshold detector foils and pairs of resonance foils have resulted in some improvement in dose estimates, as this approach allows a more realistic account to be taken of the neutron spectrum involved. (100 references) (auth)

394 COMPARISON OF DIFFERENT DOSIMETRY METHODS AND INSTRUMENTS IN THE RADIATION FIELDS OF PROTON ACCELERATORS AT THE JOINT INSTITUTE OF NUCLEAR RESEARCH. Aleinikov, V. E.; Arkhipov, V. A.; Vinogradov, V. F.; Komochkov, M. M.; Mokrov, Yu. V.; Salatskaya, M. I.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 363-373 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In Russian).

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The purpose of the work described was to establish the degree of reliability of the results of individual monitoring and operational measurements of neutron and mixed-radiation dose equivalents outside the shielding of high-energy accelerators. The degree of reliability was determined by comparing measurements from routine control instruments with proven values—dose equivalents established by means of a Bonner spectrometer and a recombination dosimeter. It was found that the readings given by most of the instruments differed at most by a factor of two with changing neutron energy distribution and radiation composition. Readings that were high by more than a factor of two were given by individual neutron dosimeters based on photographic emulsions when used in radiation fields in which the contribution of relativistic neutrons to the total dose equivalent exceeded 10%. (auth)

395 COMPARISON OF DOSE DERIVATION METHODS FOR THE UKAEA PERSONNEL CRITICALITY DOSIMETER FOR A VARIETY OF NEUTRON SPECTRA. Delafield, H. J.; Boot, S. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 375-387 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Dose estimates may be derived from the personnel criticality dosimeter based on the induced activities of the detector components alone, or by incorporating body sodium-24 measurements. Different methods of interpretation have been compared experimentally by exposing dosimeters on man phantoms to pulsed radiation from critical assemblies producing widely differing neutron spectra. In a supporting theoretical study the performance of the dosimeter was assessed for further neutron spectra representative of possible nuclear accidents. Both studies showed that the dose estimate based on the measured detector gold and sulphur activities was acceptable, except for spectra rich in intermediate energy neutrons. In this case only a limited improvement was obtained on utilizing the $^{115}In(n,n')^{115m}In$ reaction, and reliance must therefore be placed on incorporating the body sodium-24 measurement. Satisfactory dose estimates can then be made providing criticality dosimeters are worn on both the front and back of the body to enable reliable corrections to be made to the observed sodium activity for the effect of thermal and intermediate-energy neutrons. Experimental measurements indicated that an 18 cm diam. cylindrical phantom filled with sodium nitrate solution and surrounded by personnel dosimeters had only limited ap-

plication as an installed dosimeter. In addition, utilization of the $^{237}Np(n,f)$ reaction has been considered as a possible improvement to the present personnel dosimeter. (auth)

396 INTERCOMPARISONS OF NEUTRON MONITORS UNDER CONDITIONS OF SIMULATED NUCLEAR ACCIDENTS. Haywood, F. F. (Oak Ridge National Lab., TN). pp 389-399 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A continuing Dosimetry Intercomparison Study was started at Oak Ridge National Laboratory in 1965 because of a need at several national laboratories to examine existing methods and procedures for interpreting monitoring data from acute personnel exposures. The specific objective of this program is to provide an experimental arrangement which will allow dosimetrists from all over the world to compare the response of their monitoring systems with those which have been widely accepted. A facility is provided whereby pulsed radiation fields are produced to simulate nuclear accident conditions, and a staff of experimental physicists is on hand for overall guidance and technical support. Since the early phases of this program, improvements have been made in the facilities, giving rise to more uniform radiation fields, and simultaneous advances have been made in monitoring systems. Much of the success of these studies is due to the earlier development of standard diagnostic tools, such as the proportional counter and neutron energy threshold detectors, and to the more recent improvements in high-speed digital computers and radiation transport programming. A brief history of the existing program is presented along with an account of some progress which has been made both nationally and internationally in the field of accident monitoring. Average results are given, showing comparisons of neutron dose and fluence, as well as gamma-ray dose for a variety of detector systems. In addition, the types of neutron monitors used throughout the program, as well as current trends in monitoring, are reviewed. (auth)

397 FAST-NEUTRON DOSIMETRY WITH SILICON DIODES: COMPARATIVE INVESTIGATIONS OF DIFFERENT COMMERCIAL TYPES. Krueger, H.; Tumbraegel, G.; Metzner, R.; Koch, H. (Forschungsinstitut, Muenster, Ger.). pp 401-409 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Several documents published during the past few years describe the utilization of wide-based silicon diodes for fast-neutron dosimetry. The results of comparative investigations of the neutron response characteristics of three commercial type silicon diodes are described, i.e., Philatron diodes (USA), type PH-30, PH-50; AB Atomenergi diodes (Sweden), type 5422; and AEG Telefunken diodes (Fed. Rep. Germany), type HL 668. These three types were tested in the dose range between 5 and 1000 rad for 3-MeV and 15-MeV neutrons. The characteristics listed below were measured and are discussed: (1) change of forward voltage as a function of the neutron dose; (2) variation of the predose (forward voltage of unirradiated diodes) for a large group of diodes; (3) differential sensitivity for 3-MeV and 15-MeV neutrons; (4) temperature influence on the forward voltage for irradiated and unirradiated diodes between −30°C and +50°C; (5) fading at room temperature for a measuring period of at least 20 days; and (6) sensitivity to γ-rays (a ratio of $D_\gamma/D_n \lesssim 10^{-3}$ was found). Special efforts were made during the investigation specifically to eliminate the fading problem. Fading is most significant immediately after irradiation and is caused by irradiation effects which are very likely to diminish and disappear. It is therefore reasonable to expect fading to be temperature dependent. For this reason, all dosimeters were heat treated before reading. A practical procedure is heating to +100°C in 2 min. Subsequently, only negligible fading occurs for several weeks. (auth)

398 SUITABILITY OF VARIOUS AREA MONITORING SYSTEMS FOR NEUTRON DOSIMETRY. Gomaa, M. A.; El-Shinawy, R. M. K. (Atomic Energy Authority, Cairo). pp 411-419 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The total neutron dose-equivalent rate emitted from one of the horizontal channels of the UA-RR-1 reactor was measured by means of: (a) commercially available dosimeters (DNA-1 dosimeter, a 12-in. sphere dosimeter, a 10-in. sphere dosimeter and a multi-sphere dosimeter), and (b) specially developed dosimeters (scintillation system and DN-3 neutron monitoring system). Experimental results indicate that the DNA-1 dosimeter and the scintillation system are to be recommended for neutron area monitoring. (auth)

399 PRELIMINARY RESULTS OF A PROGRAM OF COMPARISON OF PERSONNEL NEUTRON DOSIMETERS. Seguin, H. (EURATOM, Luxembourg). pp 421-427 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Under its personnel dosimetry intercomparison program the Commission of the European Communities has carried out a series of comparisons involving neutron dosimeters. These experiments, whose aim is to standardize and improve the quality of physical monitoring in radiation protection, were carried out in the following manner: the personnel neutron dosimeters were irradiated under well-defined conditions, i.e., with monoenergetic neutrons of energies ranging from 0.5 to 13.6 MeV and with neutrons from an Am-Be source. Since at neutron energies of 0.5 MeV practically nothing was detected, the lower energy was raised to 0.7 MeV in the second series of experiments. The experimental conditions and the generation of monoenergetic neutrons are described and the error during irradiation is evaluated. The results of the two series of experiments are presented and compared. The dose equivalent is clearly underestimated in the energy range lower than 0.5 MeV. For 4.5 MeV, comparison of the two series shows an improvement in the case of almost all the participating institutes. The dose equivalents were overestimated in the case of higher energies. (auth)

400 CALIBRATION OF NEUTRON REM-COUNTERS WITH PHOTONEUTRON SOURCES. Ledermann, H.; Bensch, F. (Atominstitut der Oesterreichischen Hochschulen, Vienna). pp 485-491 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A substantial portion of the neutron spectrum in the vicinity of an operating reactor may consist of intermediate-energy neutrons. Neutron rem-counters are suitable for monitoring such neutrons, but the calibration of these counters with (α,n) sources is not ideal because of the broad emission spectrum of such sources. Photoneutrons from several radioactive sources are nearly monoenergetic, but little information on the yields and spectra of photoneutron sources is available and appropriate types of photoneutron sources (SbBe, GaD_2O, NaD_2O, NaBe, etc.) were therefore investigated to obtain better neutron yield values (neutrons/Ci) and the actual emission spectra. The results of this investigation were applied to the calibration of a Kaman Nuclear D-300 and a Nuclear Enterprises 0075 neutron dosimeter. In some cases it was necessary to surround the photoneutron source with lead shielding to reduce the intense high-energy γ-background. It has been shown that the use of lead shielding has only a negligible influence on the neutron emission spectrum. (auth)

401 DETERMINATION OF THE SPECTRAL ENERGY FLOW DENSITY OF SOFT X RAYS BY CALORIMETRIC ATTENUATION MEASUREMENTS. Saebel, M.; Schmidt, T. (Erlangen-Nuernberg Univ., Erlangen, Ger.). Strahlentherapie; 146: No. 3, 339-344(Sep 1973). (In German).

The energy spectrum of x-rays used for irradiation experiments is not known as a rule. The determination of the spectrum from the calorimetrically measured energy flow density is described by the example of a radiation of 30 and 50 keV bremsstrahlung energy. Using this method, the conversion from air to the relative energy flow density by the mass energy absorption coefficient is not necessary, in contrast to the measurement of attenuation with ionization chambers. (GE)

402 DOSIMETRY OF MIXED n−γ RADIATION. Briskman, B. A.; Novgorodtsev, R. B. At. Energ. (USSR); 36: No. 1, 39-49 (Jan 1974). (In Russian).

The status of mixed n−γ radiation dosimetry, determination of the gamma and neutron components of mixed radiation absorbed doses, is analyzed. Calorimetric, chemical, and ionization methods of dosimetry are examined. The common method of separate determination of dose components is shown to result in large errors because it is based on preliminary measurement of total doses in two materials. Relaxometer and outstripping calorimetric methods, which make it possible to considerably reduce the error in measuring dose components, are described. Polyethylene and graphite are recommended as a standard pair of materials for the measurement of dose structure. The dose rate in a broad range of chemical elements can be calculated from the experimental value for polyethylene. The application

of chemical methods for separate dosimetry is not considered to have a future. (130 references) (auth)

403 LIQUID IONIZATION CHAMBER WITH HIGH SPATIAL RESOLUTION. Wickman, G. (Umeaa Univ., Sweden). Phys. Med. Biol.; 19: No. 1, 66-72(Jan 1974).

An ionization chamber is described that has a sensitive volume of 2 mm^3 and employs a dielectric liquid as the ionization medium. The fundamental properties of general saturation, temperature dependence, and radiation quality dependence for electron radiation are given. The usefulness of the chamber is illustrated by measurements of absorbed dose build-up at the surface of, and the absorbed dose distribution behind a conventional ionization chamber in a polystyrene phantom irradiated with high energy electrons. (auth)

404 USE OF INDUCED ACTIVITY OF ^{24}Na FOR NEUTRON DOSIMETRY. Prouza, Z. (Ceske Vysoke Uceni Technicke, Prague); Rakovic, M.; Hermanska, J.; Novotny, J.; Pittermann, P. Radioisotopy; 14: No. 3, 467-479(1973). (In Czech).

Results are reported of dose determinations from neutron exposures of small laboratory animals and their phantoms in the thermal column TK 11 of the nuclear reactor in the Nuclear Research Institute, Rez. The doses were determined on the basis of absolute measurement of the whole-body activity of ^{24}Na in irradiated objects. The flux density distribution of thermal neutrons in the vicinity and within the objects was estimated with a system of Au-activation dosemeters. After two hours irradiation of the experimental objects a specific activity a = (6,298 ± 0,984). 10^{-4} μCl ^{24}Na/mg ^{23}Na was found, corresponding to an average whole-body dose from neutrons Dn = (8,05 ± 1,32) rad. (auth)

405 CAVITY CORRECTIONS IN DOSIMETRY OF x-γ OR ELECTRON BEAMS AND THE INFLUENCE ON THE ENERGY DEPENDENCE OF VARIOUS DOSEMETERS. Janssens, A.; Eggermont, G.; Jacobs, R.; Thielens, G. (Ghent Ryksuniversitet). J. Belge Radiol.; 56: No. 5, 457-466(1973). (In Dutch).

A survey is given of methods to calculate absorbed dose in a cavity for an incident photon-flux. Particular attention has been given to cavity-theory. The calculated energy dependence of LiF- and $CaSO_4$ teflon dosemeters, based on the Burlin theory and a modified Burlin theory is given, together with the expected doses in a tooth-nerve and in the gut-$BaSO_4$ interface. (auth)

406 RESULTS OF AN INTERCENTER COMPARISON OF THE CALIBRATION OF ^{60}Co DOSIMETERS USING $FeSO_4$. Wambersie, A. (Univ., Louvain, Belg.); Prignot, M.; Dutreix, A. J. Radiol., Electrol., Med. Nucl.; 54: No. 11, 835-839(Nov 1973). (In French).

Twenty French, Swiss, and Belgian radiotherapy centers participated in an $FeSO_4$ intercomparison for the calibration of ^{60}Co dosimeters. If the mean of the values obtained at the Gustave-Roussy Institute (Villejuif) and the Cancer Institute (Louvain) is used as a reference, then 10 centers obtained values agreeing within ±2% with the reference value, 3 centers obtained values agreeing within 3 to 5% with this value, and 5 centers obtained values differing by more than 5% from this value (the maximum discrepancies were +16% and −15%). $FeSO_4$ was found to be an excellent chemical dosimeter for these comparisons. The mean standard deviation of the results was of the order of 0.5%. The reproducibility is thus at least equal to that usually obtained. It is generally recognized that $FeSO_4$ produces better results than LiF. The samples were not sent by post but exchanged at meetings or intercenter visits. No comparisons were made after May 1971 as the development of national organizations allowed the various radiotherapy centers access to facilities for controlling and calibrating their own dosimeters. It is emphasized that no attempt has been made to establish a calibration laboratory and that calibrations effected were made as a result of requests. (FR)

407 RADIOTHERMOLUMINESCENT DOSIMETER READERS. Chenault, R.; Prigent, R. (CEN, Fontenay-aux-Roses, France). pp 241-258 of Seventh National Congress of the Health Physicist's Association. Marseilles; Centre National de la Recherche Scientifique (1973). (In French).

From 7th national congress on control of ionizing radiation: pollution, dosimetry, applications; Marseilles, France (16 May 1972).

This apparatus, which was specially designed for measurements of luminescent phenomena presented by LiF, can also be used with other radiothermoluminescent materials (e.g., alumina and lithium borate). The heating regime used was chosen in such a way as to eliminate low temperature light emission (problematic because of its instability). A preheating stage (constant temperature) is introduced before the classical heating stage (normal temperature rise) during which the measurements are made. The photometric part of the apparatus consists of a photomultiplier (fed by a transistorized variable e−h−t (800 to 1300 volts) power supply) which delivers a current of between 10^{-9} and 10^{-4} A depending on the luminous intensity of the dosimeter. The results of the measurements are delivered in both analogue and digital form. An automatic switch selects the appropriate sensitivity range. The results can be provided automatically in the form of a printout. The apparatus can operate in two distinct ways: by plotting the spectrum (recording the P. M. output current) and integrating this current (display on digital device of the integrated value and its subsequent storage in a memory): by plotting the spectrum and measuring the peak value of the current (displayed and stored in a memory). (FR)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 1026 and 1033.

408 (BARC/I-218) STABILIZATION OF SCINTILLATION GAMMA RAY SPECTROMETER. Sidhu, N. P. S. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 10p. INIS.

The design, construction and performance of a transistorized Spectrum Stabilizer for a scintillation spectrometer are described. The spectrometer can be used to measure half-lives of radioisotopes, of the order of a few minutes, regardless of the source strength. The spectrum to be measured is not distorted by stabilization as the reference peak does not appear in the spectrum. (INIS)

409 (CONF-721231-PA, pp 125-140) NUCLEAR LEVEL STRUCTURE STUDIES USING RECENT TECHNIQUES. Trehan, P. N. (Panjab Univ., Chandigarh, India). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

A general description of contemporary nuclear spectroscopy is given first. Attention is then directed to the study of de-excitation gamma rays observed in slected cases in the medium, medium-heavy, and heavy (deformed) mass regions. Energy-level diagrams are shown for ^{60}Ni, ^{127}I, and ^{160}Dy. The relative usefulness and limitations of each method are considered. (6 figures) (RWR)

410 (INIS-mf-911) PROPOSAL FOR A NEW TYPE OF AN ALPHA−BETA−GAMMA SCINTILLATION SPECTROMETER. Kalish, Y. 1973. 1p. INIS.

From transactions of the Israel Nuclear Society. Vol. 1; Yavne, Israel (26 Jun 1973).

An invention of a new type of spectrometer for measuring radioactivity from samples emitting alpha, beta and gamma radiation is described. The advantages of the spectrometer as compared with existing systems are discussed. (INIS)

411 (JINR-P10-7723) TWO DIMENSIONAL ANALYSIS WITH DIGITAL DISCRIMINATORS AND THE HP 2116C COMPUTERS. Arl't, R.; Medved, S. V.; Sinaev, A. N.; Khan, B.; Khaupt, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 16p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

The two-dimensional analysis using a system consisting of 16 digital discriminators, the AI-4096 analyzer, being a buffer memory, and a small HP 2116C computer is described. The selected and sorted data are stored on the magnetic disc. The system can record up to 16 spectra, each containing 4096 channels. It allows displaying the process of data storage in any spectra. The flow-chart of the main program is presented. (auth)

412 (SGAE-2235) AUXILIARY PROGRAM FOR MULTICHANNEL DATA PROCESSING. Krotz, W. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Jan 1974. 24p. (In German). Dep. NTIS (U. S. Sales Only) $4.25.

The program package used in gamma spectroscopy at the Research Center Seibersdorf is described. It serves for input of multichannel data coming from multichannel TMC4096 or from Diana magnetic tape into the core memory of the PDP11 and for management of the data in a structure containing three files on the magnetic disk RK05. The connection between TMC and Diana on one side and the UNIBUS of the PDP11 on the other side is formed by a CAMAC Data System. (auth)

413 DETERMINATION OF THE EMISSION PROBABILITIES OF GAMMA RAYS BY MEANS OF A Ge(Li) SPECTROMETER. Schoetzig, U.; Debertin, K.; Weiss, H. M. PTB Mitt.; 83: No. 5, 307-312(Oct 1973). (In German).

The gamma-ray emission probability per decay can be de-

termined directly from the decay rate of the source and the pulse rate in the corresponding peak measured with a calibrated Ge(Li) spectrometer. Different methods for the peak evaluation and corrections for counting losses due to pile-up, dead time and summation are discussed in detail. By using carefully calibrated sources and applying these corrections, the efficiency of the spectrometer between 0.25 and 3 MeV was determined with an uncertainty of less than ±1%. From measurements of ^{131}I and ^{88}Y, the following emission probabilities (w) were obtained: ^{131}I, 364 keV radiation: w = 0.825 ± 0.004, ^{88}Y, 898 keV radiation: w = 0.943 ± 0.005. (GE)

414 APPLICATION OF THE BARRIER METHOD TO SEMICONDUCTOR SPECTROMETERS FOR NUCLEAR RADIATION. Eichinger, P. (Technische Univ., Munich); Kallmann, H. Z. Naturforsch.; 28a: No. 12, 1888-1891(Dec 1973).

High-purity semiconductor crystals with low thermal generation rate such as Si and Ge at 77°K have been operated as radiation spectrometers when sandwiched between two thin insulating barrier layers without any preparation besides etching. The working time of such devices is determined by the ratio of the charge on the capacitor formed by the semiconductor surface, the insulating layers and the metal contacts, to the total charge generation rate in the semiconductor volume (thermal generation and absorption of ionizing radiation). Typical working times of 10 h for Si and 1 h for Ge have been obtained with gamma resolution comparable to junction detectors. Periodical recharging of the detectors can be performed with light flashes in a very short time so that the dead time is negligible. Operation without the presence of an external electric field is possible due to insulator interface charge trapping. (GE)

415 MOESSBAUER SPECTROMETER EMPLOYING DELAYED $\gamma-\gamma$ COINCIDENCES. Alekseev, V. P.; Baldokhin, Yu. V.; Nefed'ev, A. V.; Stukan, R. A. (Inst. of Chemical Physics, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 6, 1006-1008 (Jun 1973).

Translated from Zavod. Lab.; 39: No. 6, 757-759(Jun 1973).

A Moessbauer system with a ^{57}Co source employing delayed $\gamma-\gamma$ coincidences is described. The 122 keV gamma ray in the cascade decay of ^{57}Co acts as the time reference for selecting the 14.4 keV gamma ray to record the gamma-resonant spectrum by delayed $\gamma-\gamma$ coincidence. (WHK)

416 THEORY OF THE REVERSE METHOD IN SLOW NEUTRON TIME-OF-FLIGHT SPECTROMETRY. Hiismaeki, P.; Poeyry, H.; Virjo, A. (Technical Research Center of Finland, Otaniemi). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 96, 1-49 (1973).

A detailed analysis using both analytical methods and computer simulation is given of the reverse time-of-flight method identified by its peculiar data accumulation from sequences of beam modulation prior to each neutron detected instead of sorting neutrons in consecutive time channels. It is shown that the reverse method in general repeats the results derived for the pulsed and the pseudostatistical methods. In connection with a Fourier chopper, however, the inherent on-line feature of the method implies direct measurement of the optimally synthetized time-of-flight spectrum, if the frequency of the chopper is varied according to any of the well-known frequency filters. Some spectra obtained by computer simulation are presented and observed to behave consistently with the theoretical calculations. A very interesting feature of a Fourier chopper with none-zero off-times lies in the possibility to accomplish spectrum filtering with one single chopper only. (auth)

417 EXPERIMENTAL DETERMINATION OF THE ELECTRONIC REGISTRATION EFFICIENCY OF A γ-SPECTROMETER. Kosina, Z. (Czechoslovak Academy of Science, Rez). Radioisotopy; 14: No. 3, 433-435(1973). (In Czech).

A simple method for the determination of the registration efficiency of detected γ-rays for a given integral counting rate and spectrum configuration and its applications in activation analysis data processing are described. (auth)

418 NEUTRON-GAMMA DISCRIMINATION IN THE TIME-OF-FLIGHT SPECTROMETER FOR FAST NEUTRONS. Reuter, K. F.; Schweitzer, T.; Seeliger, D.; Seidel, K.; Unholzer, S. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 698-699(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

419 METHODOLOGY OF THE MEASUREMENT AND EXTRACTION OF CONTINUOUS SPECTRA OF INELASTICALLY SCATTERED FAST NEUTRONS. Giera, H. D.; Krause, R.; Hermsdorf, D.; Sassonoff, S.; Seeliger, D.; Seidel, K.; Wohlfahrt, D.; Zill, K. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 702-704(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

420 DRAWINGS FOR A NEUTRON TIME-OF-FLIGHT MEASURING SETUP WITH 8 DETECTORS AND AN ON-LINE COMPUTER FOR DATA ACQUISITION AND CONTROL OF EXPERIMENTS. Krause, R.; Meiling, W.; Seeliger, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 730-731(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

421 SOME UNCONVENTIONAL METHODS OF GAMMA-SPECTRA PROCESSING. Hnatowicz, V. (Czechoslovak Academy of Sciences, Rez). Radioisotopy; 14: No. 4, 677-680(1973). (In Czech).

A short survey of procedures used for determination of the number of components of complex multiplets in gamma spectra, obtained on spectrometers with Ge(Li) semiconductor detectors, is given. These procedures are a necessary complement of the current methods of line identification in those cases where a complex gamma spectrum has to be processed automatically. The principles of the statistical method for a fast determination of line parameters are briefly explained. This method was successfully applied in the EPOS programme. (auth)

422 DETECTION LIMITS IN THE SPECTROMETRY OF LOW GAMMA ACTIVITIES. Chudy, M.; Usacev, S.; Povinec, P. (Katedra Jadrovej Fyziky, Bratislava). Radioisotopy; 14: No. 4, 657-667(1973). (In Slovak).

A comparison was made of the detection limits for different spectrometer methods (simple, anti-Compton, coincidence and multidimensional spectrometer), using detectors with NaI(Tl) or Ge(Li) crystals. (auth)

High Energy Physics Instrumentation

423 (CONF-720724-P1, pp 500-525) CORPUSCULAR PHOTOGRAPHIC OBSERVATIONS OF ENERGETIC PARTICLES IN SPACE. Filz, R. C. (Air Force Cambridge Research Labs., Bedford, MA). 1972.

From eighth international conference on nuclear photography and solid state track detectors; Bucharest, Romania (10 Jul 1972).

A summary of techniques utilized at Air Force Cambridge Research Laboratories over the last decade to study energetic particles in space is presented. Technique is emphasized over results; indeed, some attempts are mentioned which, while yielding little or no energetic particle data, do represent advances that could be utilized for future studies. Flights using satellites, rockets, and balloons are discussed. Magnetic cutoff analysis, recovery and processing, scanning results, and the angular distribution are described. Analysis of the dip angle distribution suggested that trans-iron nuclei are basically a low-energy phenomenon, although a more thorough analysis is required for final evaluation of the data. (17 figures, 1 table) (RWR)

424 (INS-TH-84) CAMAC READOUT SYSTEM FOR WIRE SPARK CHAMBER. Inaba, S.; Sugano, K. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). 31 Jul 1973. 31p. (In Japanese). NTIS (US Sales Only).

A CAMAC system for magnetostrictive readout of wire spark chambers has been constructed. The whole system consists of three kinds of modules, i.e., a control module for the wire spark chamber, an interval scaler module, and a clock generator module. The interval scaler module has four independent inputs and eight 16-bit memory registers. The time intervals between the pulses in a pulse train of each input are counted by the 20 MHz clock of the clock generator module. The scalers can be used either in dual or quad mode, sharing the eight registers with the two or all four inputs, respectively. Since each CAMAC module is standardized, it may be used not only for wire spark chambers but also for other CAMAC data processing. The circuits are mostly composed of integrated circuits to guarantee high confidence. (auth)

Radiometric Instruments

425 RADIOISOTOPE VIBROVISCOSIMETER. Lishanskii, B. A.; Osmachkin, B. P.; Mikhailov, N. V. (Kharkov House-Building Group No. 1). Ind. Lab. (USSR) (Engl. Transl.); 39: No. 2, 316-317(Feb 1973).

Translated from Zavod. Lab.; 39: No. 2, 224-225(Feb 1973).

A radiometric gage for measuring the effective viscosity of dispersed materials when exposed to vibrations is described. The shift of a point source of gamma radiation is measured by using the ratio of the radiation intensities at two detectors located at a known distance. The effective viscosity of a water–cement suspension for vibration amplitudes of 0.22 and 0.30 mm with a 5.5-cm diameter ball having a density of 7.8 g/cm^3 is plotted. (WHK)

426 MEASURING SOIL MOISTURE WITH THE AID OF ISOTOPES. Petrov, P. Pochvozn. Agrokhim.; 7: No. 3, 3-8 (1972). (In Bulgarian).

The application of radioactive methods to determine soil moisture for irrigation purposes, is discussed. The NIV-1 neutron probe, manufactured by the Izotop Corporation (USSR), has been tested in the fields of the Sofia Irrigation System. To compare and assess the accuracy of the device, simultaneously with measurements by the neutron method, samples have also been taken to determine soil moisture by the classic thermal-weight method, which is believed to be the most accurate one. Results show that in the case of cinnamonic forest soils the absolute error in determining their moisture content with NIV-1 range from 0.04 to 3.03%, while the relative error was from 0.02 to 17.00%. In the case of the smolnic soils, the absolute error varied from 0.99 to 2.90%, and the relative error from 4.0 to 15.70%. Moisture content measurements of the alluvial-meadow soils indicated an absolute error of from 3.27 to 2.93%, and a relative error of 11.00 to 11.70%. The accuracy found gives grounds to believe that the measurement of soil moisture to determine the watering time in irrigation systems, carried out by the neutron method, is very suitable for routine work. (auth)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to abstract 1760.

427 (AD-768212) TRANSIENT RADIATION EFFECTS RESEARCH. Final Report, 3 April 1972–30 June 1973. Azarewicz, J. L.; Berger, R. A.; Colwell, J. F.; Green, B. A.; Flanagan, T. M. (Intelcom Rad Tech, San Diego, Calif. (USA)). Jul 1973. Contract DAAG39-68-C-0060. 174p. (RT-8044-1; HDL-TR-60-2). NTIS $10.75.

The theory of displacement damage in semiconductors has been used to investigate the effect of neutron energy on damage curves and short-term annealing, to derive a curve of equivalent 1-MeV electron fluence for irradiation by protons, and to calculate the relative displacement damage produced in GaAs by electrons of various energies. The results of optical and electrical studies on GaAs irradiated at room temperature with 1- and 30-MeV electrons, together with postirradiation annealing data, are presented. Electron irradiation of high-purity n- and p-type silicon yielded information on the energy level of the donor and acceptor states of a defect assumed to be the isolated vacancy. The results are presented of investigations to determine the cross sections for capture of holes by negatively charged gold atoms in gold-doped n-type silicon. A study was initiated of the recombination lifetime at low temperature in specially doped silicon used for infrared detector fabrication, and preliminary results are presented. Development of a fast-time-resolution optical absorption apparatus has involved testing of materials for Cherenkov sources. Results of these studies are presented. Charge injection and storage release in two common capacitor materials, Mylar and Teflon, have been studied. The charge storage is dependent on the nature of this interface and, in some cases, on the bias temperature history. (auth)

428 RADIATION DAMAGE AND HARDENING EFFECTS ON COMPENSATED GaAs LIGHT-EMITTING DIODES. Share, S.; Epstein, A. S.; Polimadei, R. A. (Harry Diamond Labs., Washington, DC). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 256-260(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Closely compensated GaAs light-emitting diodes utilizing Zn–Si and Si–Si impurity combinations have been used to study the effects of both gamma and neutron irradiation on the radiative light generating mechanism as well as on the carrier lifetime and injection mechanism in these diodes. The following results have been noted: 1) the light-generating mechanism appears to be affected more strongly by ^{60}Co irradiation than by neutron irradiation; 2) the shallow-lying acceptor radiative center (Zn) appears to be more susceptible to ^{60}Co irradiation than the deeper-lying center (Si); 3) neutron irradiation appears to introduce non-radiative centers which primarily affect the lifetime and injection mechanism. A means of radiation hardening GaAs light-emitting diodes by isovalent substitutional alloying of phosphorus is reported. A minimum reduction in quantum efficiency on neutron irradiation occurs for the alloy composition $GaAs_{.70}P_{.30}$. (auth)

429 CHANGES IN THE ALTERNATING CURRENT (AC) CONDUCTIVITY OF BLACK SILICON CARBIDE VARISTORS AT IRRADIATION WITH REACTOR NEUTRON RADIATION. Ribarov, S.; Gospodinov, M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 95-100(1973). (In Bulgarian).

Investigations were carried out on the changes in the alternating current (AC) conductivity of non-linear semiconductor resistors from black silicon carbide (varistors) as a result of irradiation with reactor neutron radiation. It was ascertained that the relative radiation change of the alternating current (AC) varistor conductivity has a negative sign at low frequencies and big amplitudes of the applied voltage and a positive sign at high frequencies and small amplitudes. The dependence of the sign of the relative radiation change of the varistor conductivity on the magnitude of the applied alternating voltage on the varisitor shows that the potential barriers and hence the capacity of the contact zones of the silicon carbide grains are not of the hard type, but of the space charge type. The increase of the grains' contact zone capacity is explained by the implantation of α-particles and lithium ions as a result of the reaction $^{10}B(n,\alpha)^7Li$ in the binding substance. (auth)

430 PHENOMENOLOGIC THEORY OF THE VARIATIONS OF THE VARISTOR CONDUCTIVITY AS A RESULT OF GAMMA IRRADIATION. Ribarov, S. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 87-94(1973). (In Bulgarian).

A phenomenologic theory is developed for the gamma induced variations of the conductivity of varistors from black silicon carbide. Its basic assumptions are the availability of peculiar, spontaneously emerging p–n transitions on the silicon carbide grain surface and the strong dependence of the properties of these transitions on the type and amount of the sorbed gases. The dependence of the relative radiation variation of the varistor current on the voltage amplitude is obtained in analytical form on the basis of most general theoretical considerations for two boundary cases at direct current voltages and sinusoidal alternating voltages with high frequencies. This dependence is studied also experimentally and good qualitative confirmation is obtained for the developed phenomenologic theory. The investigation appears as a new argument in favor of the hypothesis explaining the non-linearity of the varistor volt-amper characteristics by means of p–n transitions spontaneously emerging on the surface of the silicon-carbide grains. (auth)

431 EFFECT OF THE BINDING SUBSTANCE ON THE VARIATIONS IN THE ELECTRIC CHARACTERISTICS OF VARISTORS FROM BLACK SILICON CARBIDE AT IRRADIATION WITH REACTOR NEUTRON RADIATION. Ribarov, S.; Gospodinov, M.; Krezhov, K. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 81-86(1973). (In Bulgarian).

Investigations on the possible influence of the thermal component of reactor neutron radiation on the conductivity of non-linear semiconductor resistors of black silicon carbide, were carried out. It is shown that by irradiation of the varistors with thermal neutrons, an intensive bombardment and implantation of α-particles and lithium nuclei on the surface of the silicon carbide single crystal grains is obtained. These particles appear as a result of the $^{10}B(n,\alpha)^7Li$ reaction during the capture of thermal neutrons by the boron grains of the binding substance. As a result of ionic implantation and generation of surface structural defects with high density, the resistance of the contact zones of the silicon carbide grains strongly increases and as a result of this the resistance of the aggregates built up from them also increases. An important conclusion is drawn from a practical point of view, namely: for manufacturing varistors resistant to neutron irradiation, substances containing no elements with big cross sections for thermal neutron capture and reactions of the (n,α) type should be used. (auth)

Miscellaneous Instruments

Refer also to abstracts 225, 698, and 2140.

432 (JUL-1009-RX) BEHAVIOUR OF GAS THERMOMETERS IN THE TEMPERATURE RANGE FROM 300 TO 3000 K. Leyers, H. J. (Kernforschungsanlage Juelich G.m.b.H. (F. R.

Germany). Zentralinstitut fuer Reaktorexperimente). Oct 1973. 53p. (In German). Dep. NTIS (U. S. Sales Only) $5.75.

The theoretical principles of gas thermometers are presented. In the experimental part of the paper it is shown that measurement and registration of temperatures up to 3,000°K is feasible by means of specially designed gas thermometers, which are described in detail. The advantages of these gas thermometers in comparison with other types of temperature sensors are described, although the latter may be less complicated with regard to technical and design features. (GE)

433 (LF-46, pp 16-20) DEVELOPMENT OF A MINIATURE AEROSOL CHARGE SPECTROMETER. Yeh, H. C.; Raabe, O. G.; Wood, B. E. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Knowledge of the electrical properties of an aerosol is useful in assessing its potential hazard. A miniature aerosol charge and electrical mobility spectrometer, suitable for use in inhalation studies with radioactive aerosol, was developed. The device is relatively inexpensive, easy to manufacture and disposable. Using polystyrene latex spheres, ranging in sizes from 0.147 μm to 1.18 μm, and flow rates ranging from 400 cc/min to 4800 cc/min, results obtained from evaluation tests were in good agreement with theoretical predictions for the performance of the device. (auth)

434 ULTRAHIGH VACUUM SYSTEM FOR ION-INDUCED CHARACTERISTIC X-RAY ANALYSIS. Beezhold, W. (Sandia Labs., Albuquerque, NM). Thin Solid Films; 19: No. 2, 387-397 (17 Dec 1973).

From International conference on ion beam surface layer analysis; Yorktown Heights, NY (18 Jun 1973).

A new ultrahigh vacuum system designed and constructed primarily for ion-induced characteristic x-ray studies is described. Details of the following four special features of interest are described: (1) an ultrahigh vacuum beam line system; (2) a multipurpose scattering chamber; (3) a windowless Si(Li) x-ray detector scheme; and (4) a target manipulator for ion beam experiments with in situ heating and cooling over the range from approximately 1200°C down to 110°K. (auth)

435 DIRECT ANALYSIS OF STABLE ISOTOPES WITH A QUADRUPOLE MASS SPECTROMETER. Caprioli, R. M. (Purdue Univ., Lafayette, IN); Fies, W. F.; Story, M. S. Anal. Chem.; 46: No. 4, 453A-454A; 456A; 458A; 460A; 462A(Apr 1974).

The capability of a quadrupole mass spectrometer for use as a high-precision instrument for the determination of isotope ratios, even under the dynamic conditions imposed by combined gas chromatography–mass spectrometry, is discussed. Example data are given for isotope abundances of argon, krypton, and xenon from reservoir samples and gas chromatography samples. (WHK)

436 ACCURATE SYSTEM FOR EVALUATING GAMMA RAY COLLIMATORS. Oberley, L. W.; Lensink, S. C.; Ehrhardt, J. C.; Christie, J. N. (Univ. of Iowa, Iowa City). Phys. Med. Biol.; 19: No. 1, 36-42(Jan 1974).

An accurate and rapid system is described for measuring the performance of γ-ray collimators. For a single radionuclide, a collimator can be fully evaluated in two days. Information is presented on ten previously unpublished collimators. (auth)

437 DEPENDENCE OF ION CYCLOTRON RESONANCE ON ELECTROSTATIC POTENTIALS. Riggin, M.; Woods, I. B. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 5, 456-469(1 Mar 1974).

The effect of the electron beam and electrostatic cell potentials on the spatial distribution of ions in a standard cyclotron resonance (ICR) cell is experimentally investigated. At low electron currents an ad hoc model of Bloom and Riggin accounting for the effect of the spatial distribution on the ICR line width and resonant field is found to describe adequately some of the complexities of the system. The influence of the distribution of initial ionic velocities on the ICR signal is also discussed and one alternate ion production technique is presented. (auth)

438 THEORY OF ION CYCLOTRON RESONANCE. Bloom, M.; Riggin, M. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 5, 436-455(1 Mar 1974).

A theoretical analysis is given of the most commonly used type of ion cyclotron resonance (ICR) spectrometer, which has a cell of rectangular cross section. Though the equations of motion of the ions in this cell are extremely nonlinear, it has been possible to simplify the analysis by exploiting the facts that the longitudinal oscillations in the trapping potential are approximately decoupled from the cyclotron motion and that the cyclotron frequency $\gg$ the trapping oscillation frequency $\gg$ the spread of instantaneous cyclotron frequencies in the trap. A method is described for constructing an ensemble of ions appropriate to the mechanism of ion production and to the various drift and trapping voltages employed in the ICR cell. Line shapes are calculated in the collisionless regime. An ad hoc "average ion" model is presented, which simplifies the analysis of the spatial distribution of the ions through the dependence of the effective ICR frequency and line width on cell voltages and dimensions. Finally, an explicit distribution function is derived for the ion kinetic energy in the cell. The effect of a uniform RF electric field at resonance is shown to increase not only the average kinetic energy, but the spread of energies as well. A substantial spread of energies is also produced by the trapping oscillations. The breadth of the kinetic energy distribution complicates the interpretation of energy dependent processes using ICR under conditions normally used up to now. Some improved techniques for the study of energy dependent cross sections are proposed. (auth)

439 ANALYSIS OF ION MOTION IN ION CYCLOTRON RESONANCE CELLS. Knott, T. F.; Riggin, M. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 5, 426-435(1 Mar 1974).

The detailed discussion of ion motion in ion cyclotron resonance cells forms the basis of any interpretation of experimental results. We show that the resonance frequency of (quasi-) cyclotron motion is a function of the ion's position in the cell, and that its drift velocity exhibits a similar dependence. These features of the motion are due to the complicated multipole structure of the electric field. In spite of this, we find simple expressions for the ion coordinates as functions of time. (auth)

440 ELECTRONIC DEVICES FOR ACTIVATION ANALYSIS: CONTROL UNIT AND ELECTRONIC COMPARATOR. Tomek, S. (Solvenska Akademie Ved, Bratislava). Radioisotopy; 14: No. 4, 669-676(1973). (In Slovak).

Activity measurements of short-lived nuclides require a perfect apparatus, enabling it to record all processes occurring during the experiment. A description is given of a control unit, enabling the automation of the activation analysis of a series of samples. An electronic comparator was developed which may replace the activation comparator in activation analysis with a neutron generator. The principles of performance, properties, and experimental results are described. (auth)

441 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR THE COMBINED STORAGE AND DISPLAY OF INFORMATION. Pooley, I. D. (to United Kingdom Atomic Energy Authority). British Patent 1,340,322. 12 Dec 1973. Filed date 4 Dec 1969. 4p.

An improvement of the information storage apparatus described in BP 1 281 991 is claimed. In the improved version the phosphor is selected from the group comprising LiF doped with U, NaF doped with U or Ce, K Mg F_3 doped with Mn, and MgF_2 doped with Mn. The apparatus comprises an electron gun and associated beam deflection system, a target comprising a wafer of phosphor capable of being damaged and annealed by electrons from the gun, means for pulsing the gun so as to produce a beam of electrons of lower and higher energy so as either to damage or anneal the phosphor, the distribution of the annealed and damaged regions being representative of information to be stored, together with means for directing a beam of exciting radiation at the target, and a photocathode for deriving readout signals from the phosphor. Means are also provided to completely erase the stored information. (UK)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 118 and 282.

442 METHOD OF PRODUCING A BARRIER FOR SEPARATION OF UF_6 GAS. Kabayama, S.; Ikeda, H. (to Sumitomo Electric Industries Ltd.). Japanese Patent 1973,20359. 16 Jul 1969. 3p. (In Japanese).

A barrier whose permeability to UF_6 gas does not decrease during isotope separation by the gas diffusion process was made by exposing it to ionizing radiation. Purified polytetrafluoroethylene powder was mixed with white oil as a pore-forming agent and then molded into barriers. The barriers were irradiated by ionizing radiation of glow discharge in an Ar atmosphere for 60 h and fluorinated with IF_5 gas. Decrease in the permeability to UF_6 was negligibly small. Radiation treatment was effective both before and after molded. (JA)

443 PROCESS FOR PRODUCING BARRIER FOR GASEOUS DIFFUSION PROCESS. Ikeda, H.; Kabayama, S. (to Sumitomo Electric Industries Ltd.). Japanese Patent 1973,3071. 13 Sep 1969. 1p. (In Japanese).

An improved method for the preparation of barriers for the gaseous diffusion process was devised by crushing the larger holes formed during the conventional preparation process. The separation factor increased with this improvement. For example, 100 parts by weight of tetrafluoroethylene resin (Daikin Ltd.) and 50 parts of perfluoroalkane (b.p. 225 to 300°C/cm kg) were mixed. The mixture was pressed under the pressure of 30 kg/cm², extruded to obtain 5 mm thickness, and then rolled to obtain the 0.05 mm thickness. Fifty percent of the perfluoroalkane in the resulting moldings is extracted by Freon 113. It is rerolled with the roll gap of 0.04 mm after drying at 50°C. Ar isotope separation factor of the resulting barrier was 85% at 500 mmHg. (JA)

444 PROCESS FOR PRODUCING A FILTER FOR GASEOUS DIFFUSION METHOD. Ikeda, H. (to Sumitomo Electric Industries Ltd.). Japanese Patent 1973,3070. 5 Sep 1969. 3p. (In Japanese).

A porous barrier for the gaseous diffusion process was prepared by using fluorine oil as a pore-forming material. A mixture of fluorine-contained polymer powder and a fluorine oil was heated to swell at a temperature lower than the melting point of the polymers for more than 1 min. After molding, the fluorine oil was extracted by Soxhlet's extractor. By heating a fluorine-contained filter prepared in a fluorine oil or with it under the above conditions and extracting the oil, the filter became porous. (JA)

445 PROCESS FOR PRODUCING MICROPOROUS BARRIER. Kabayama, S.; Ikeda, H. (to Sumitomo Electric Industries Ltd.). Japanese Patent 1973,3068. 2 Apr 1969. 2p. (In Japanese).

A mixture of fluorine-contained resin powder and fluorine oil as liquid pore forming agent is molded by using conventional procedures. The resulting moldings are heated, under an atmospheric or higher pressure, in the fluorine oil at a temperature higher than the melting point of the resin, to sinter the resin of the moldings. Then, the porous filter of fluorine-contained resin having very small pores is obtained after extracting said fluorine oil by solvents. The fluorine oil is prepared when hydrogen of paraffin or ether is completely substituted by fluorine. The fluorine oil has a higher boiling point and decomposition point than that of hydrocarbon paraffin. In the present process, particularly using the fluorine oil as a pore forming agent, the fluorine oil has a similar quality to the resin, therefore, it does not affect the fluid, even if it remains in the resin. For example; a mixture of 100 parts by weight of polytetrafluoroethylene M-12 (Daikin Industries Ltd.) and 50 parts of F'omblin YR (Montecatini-Edison Co.) is extruded under a pressure of 300 kg/cm² and molded. The molding is sintered in the heated F'omblin YR at 343°C for 10 minutes. Then the F'omblin YR is extracted by Daifeon S-3 (Daikin Ltd.) for 20 h by using a Soxhlet's extractor, and is dried in vacuum. The resulting porous filter has the following characteristics: air permeation factor of 2.5×10^{-4} mole/cm²/minute/cmHg; average pore dimension of 380 Å; and BFT surface of 2.9 m²/g. (JA)

446 PROCESS FOR PRODUCING A BARRIER FOR ISOTOPE SEPARATION. Kamizyo, E. (to Sumitomo Electric Industries Ltd.). Japanese Patent 1973,7032. 14 May 1969. 4p. (In Japanese).

A barrier for isotope separation was prepared by the following steps. Fine Al_2O_3 powder having an average particle diameter of 500 to 3000 Å is packed under a pressure into a 100 to 325 mesh annealed metallic gauze. Sheets having plasticity and being decomposed by heating to eliminate, for example, parchment paper, are put on both sides of the gauze with the powder and pressed at 2 to 15 tons/cm². The structure is sintered at 1000 to 1300°C. For uniformly filling the powder in the gauze, an adhesive material, such as methyl cellulose or polyvinyl alcohol, is added to Al_2O_3 with an organic solvent or water. For example, a 100 mesh Ni-gauze sufficiently annealed at 1000°C in a hydrogen atmosphere for 2 h and the high-purity α-Al_2O_3 powder having an average particle diameter of 0.3 μ are used. The meshes of the gauze are filled with the powder under the pressure of 10 kg/cm², then the gauze with the powder is cut to pieces of 55 mm in diameter. The piece is put between two sheets of parchment paper and pressed under a pressure of 10 tons/cm² and sintered at 1200°C for 2 h in a hydrogen atmosphere. During sintering the paper burns out. The properties of the barrier having 100 μ in thickness and 55 mm in diameter are as follows: air permeability—5.4×10^{-5} mole air/cm²/cmHg/min; Ar isotope separation factor—85% at 10 cmHg 70% at 50 cmHg an average dia of holes; 450 Å number of holes—4.5×10^9/cm². Corrosion resistance for UF_6 gas is good. (JA)

Isotopic Power Sources

Refer also to abstracts 226, 227, and 2021.

447 (ARCO-3057-16) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM. Quarterly Progress Report, November 1, 1973—January 31, 1974. (Arco Nuclear Co., Leechburg, Pa. (USA)). 1974. Contract AT(11-1)-3057. 72p. Dep. NTIS $5.45.

The results of development work performed during the period from November 1, 1973 to January 31, 1974 are reported. Information is included on: initial human implant data; pulse rate data for humans and dogs following implantation; life test data on pacemakers; production data; performance effects of moisture conditions; stack emission of PuO_2 following cremation; capsule leak test results; and results of impact testing of titanium, plutonium—rhodium, and tantalum—tungsten outer capsules. (LCL)

448 (MLM-2134) ADVANCED HEAT SOURCE CONCEPTS. Selle, J. E. (Mound Lab., Miamisburg, Ohio (USA)). 10 Apr 1974. Contract AT-33-1-GEN-53. 8p. Dep. NTIS $4.00.

Recent trends in heat source programs indicate the feasibility of a modular approach to heat source design. In this approach, modules, comprised of a number of individually encapsulated units or capsulettes, are stacked together to form one heat source. Each capsulette can independently survive impact and post-impact containment. Such heat sources are useful for electrical power generation in space. (auth)

449 (MLM-CF-69-6-161) DART II SUMMARY REPORT. Johnson, E. W.; Phipps, K. D. (Mound Lab., Miamisburg, Ohio (USA)). 19 Sep 1969. Contract AT-33-1-Gen-53. 34p. Dep. NTIS $4.75.

Declassified 29 Aug 1973.

The DART (Decomposed Ammonia Radioisotope Thruster) II system was tested for three weeks in a space-simulating vacuum chamber. The performance of the thruster met the desired design values originally set forth by the systems contractor. The thruster was powered by a heat source which consisted of 155.95 W(t) of plutonium-238 dioxide microspheres doubly encapsulated in a tantalum-10 wt % tungsten liner and a TZM (a tantalum-zirconium-molybdenum alloy) strength member. (auth)

450 (MND-3062-27) COMPATIBILITY OF STRONTIUM SPACE FUEL FORMS. Miraglia, F. J. Jr. (Martin Marietta Corp., Baltimore, Md. (USA)). Jun 1966. Contract AT(30-1)-3062. 105p. Dep. NTIS $8.25.

Declassified 29 May 1969.

The compatibility of strontium fluoride and strontium metal, both of which are candidate space fuels, with various encapsulating materials is presented. A summary of the procedures used in preparing, testing and analyzing the specimens and a presentation of the results obtained are given. For the 19 month test period at 925°C, it has been concluded that Haynes 25 are the material most compatible with the strontium fluoride fuel and the decay products of ^{90}Sr, ZrO_2 and ZrF_4. The presence of Zr metal in the fluoride fuel matrix significantly affected the com-

patibility of the metals tested. With Zr metal present, Hastelloy X proved the better fuel containment material in a 4 month test at 925°C. Short term 'scoping' tests of the compatibility of strontium metal with various materials at low (700°C) and high (925°C) temperature indicated that molybdenum and stainless steel 321 were the most compatible materials with the strontium metal. (auth)

451 (TID-24818, pp 334-351) $^{238}PuO_2$ CERMET FUELS DEVELOPMENT. Pobereskin, M.; Pardue, W. M. (Battelle Memorial Inst., Columbus, OH). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A program is underway at Battelle-Columbus to develop a composite $^{238}PuO_2$ isotopic fuel form for SNAP devices. Initial studies defined Mo and MgO as the most suitable metal and ceramic materials for development. The selected approach involves coating of sol-gel PuO_2 microspheres with the matrix materials by chemical vapor deposition. Subsequently, the coated particles are uniaxially hot pressed to numerous desired shapes. Properties of the fuel form have been measured to a temperature of 1500°C, including thermal conductivity, thermal expansion, mechanical strength, oxidation resistance, thermal-shock resistance, and compatibility. All results indicate that the cermet $^{238}PuO_2$ structure is a quite promising advanced isotopic fuel form. (auth)

452 (TID-24818, pp 352-364) COMPATIBILITY OF REFRACTORY METALS WITH $^{244}Cm_2O_3$. DiStefano, J. R. (Oak Ridge National Lab., TN). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

One of the primary requirements of a radioisotopic heat source to be used in a power generator is compatibility with its container. In thermionic converter systems, the temperatures required exceed 1500°C, and refractory metal or alloys are required as container materials. Results of 1000-h tests at 1650 and 1850°C in which Ta, T-111, Ta-10% W, Mo, TZM, W, and W-26% Re were tested with $^{244}Cm_2O_3$ are described. The most serious interactions were found with tantalum and tantalum alloys at 1650°C. All materials showed good compatibility with $^{244}Cm_2O_3$ at 1850°C, though fuel migration was observed in tantalum-base capsules at this temperature. (auth)

453 MATERIAL STUDY OF $^{228}ThO_2$ AS A HIGH TEMPERATURE HEAT SOURCE FOR THERMIONIC CONVERSION. de Bruyne, R. Louvain, Belgium; Univ. Louvain (1973). vp. (In Dutch). Centre d'Etude de l'Energie Nucleaire, Mol, Belgium.

The problems encountered when using $^{228}ThO_2$ contained in a tungsten capsule as a high-temperature (1700°C and up) energy source for thermionic converters were investigated. It was evident that the phase diagram Th–W–O with the emphasis on the quasi binary system ThO_2–WO_3, would be very important. Consequently, the system ThO_2–WO_3 was studied and information about ternary sections from 1200 to 2000°C was gathered. Ternary compounds ($Th(WO_4)2$ and Th_xWO_3) were studied. It was possible to predict, from the binary diagram ThO_2–WO_3, the behavior of the heat source with a certain degree of accuracy. Accurate simulation studies of the radioactive decay, were carried out. The chemical composition of the fuel after certain decay times (up to 24 months) was simulated and heat treatments at 1700°C for 14 days, or until equilibrium was reached, were made. The effect of an oxygen getter (tungsten) was studied. It can be concluded that the use of the oxygen getter tungsten and the dissolution of the isotope ^{228}Th with natural thorium will result in a stable fuel for use at 1700°C for a reasonable long time. A venting system consisting of a ThO_2–W cermet was studied and designed to restrict the pressure built up in the capsule due to helium formation. Helium, argon, and xenon permeabilities were measured. More recent developments in this venting system research are indicated. (auth)

Radiation Sources

Refer also to abstracts 381, 400, and 1784.

Design and Fabrication

454 (JAERI-M-5293) IRRADIATION APPARATUS FOR THE CALIBRATION OF GAMMA SURVEY INSTRUMENTS. Okuyama, N.; Minami, K.; Simizu, S.; Fukuda, S. (Japan Atomic Energy Research Inst., Tokyo). Jun 1973. 21p. (In Japanese). NTIS (US Sales Only).

The irradiation apparatus designed for the calibration of gamma survey instruments, including pocket dosimeters, personal thermoluminescence dosimeters, and low-range survey meters used in routine radiation protection are described. The apparatus is equipped with a 50 mCi sealed radium source and incorporated with adequate mechanical and electrical safety devices to prevent any accidental radiation exposure. The exposure rates at various distances from the source and the rates due to scattered gamma-rays are given in the appendix. (auth)

455 NEGATIVE NEUTRON SOURCE IN THE eV REGION. Mijnheer, B. J.; Aten, A. H. W. Jr. (Central Bureau for Nuclear Measurements, Geel, Belg.). pp 335-340 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A simple moderating system, consisting of a radioactive neutron source inside a cadmium-covered polythene cylinder, can be used to perform detector calibrations in the eV region. The method consists in measuring the difference in response of a neutron detector to this facility and to the cylinder surrounded with a layer of 2 mm of indium. The energy spectrum of the negative neutron source was calculated by using the fact that the experimentally determined slowing down spectrum can be accurately represented by a 1/E distribution in this energy region. The spectrum of the negative neutron source was experimentally checked by using a thin BF_3 counter. The flux density of the source was determined with cadmium-covered gold foils. The thermal-, intermediate- and fast-neutron components of the same moderator assembly were also determined. The system has been used to calibrate moderating spheres with different types of thermal neutron detectors inside. (auth)

456 DOSIMETRY AND FACILITIES OF UCD OUTDOOR-INDOOR ^{60}Co IRRADIATOR. Momeni, M. H.; Worden, L.; Goldman, M. (Univ. of California, Davis). Health Phys.; 26: No. 5, 469-472(May 1974).

To facilitate the study of the late effects of low-level continuous whole body γ irradiation of mammals for extrapolation to man, an outdoor-indoor ^{60}Co irradiator has been designed to provide continuous exposure ranges of 1 to 1250 mR/hr in the field over a 5 yr period. A floor plan of the control and animal irradiation rooms is shown. The techniques used to overcome the reduction of exposure rate due to decay of the 340 Ci ^{60}Co source over the 5 yr period are presented. An exposure rate map of the facility, exposure rates of the indoor field against height and iso-exposure rate curves for the room are shown. Monitoring facilities are discussed. (UK)

Industrial Uses

Refer also to abstracts 119, 174, 176, and 499.

LIFE SCIENCES

Radiation Effects on Biochemicals

Refer also to abstracts 125, 127, 142, 487, 497, 505, 506, 516, and 529.

457 (ORO-3630-19) PHOTOREPAIR OF uv DAMAGE TO DNA: PURIFICATION AND PROPERTIES OF THE DNA PHOTOLYASE (THE DNA-PHOTOREACTIVATING ENZYME). Progress Report, August 1, 1973–July 31, 1974. Werbin, H. (Texas Univ., Dallas (USA). Inst. for Molecular Biology). 1974. Contract AT(40-1)-3630. 9p. Dep. NTIS $4.00.

A membrane binding technique was developed to assay DNA-photolyase. Results of studies of the kinetics of yeast DNA uv damage and repair mechanisms and the role of DNA-photolyase in the photorepair of uv damage to DNA are reported. (CH)

458 EFFECT OF IONIZING RADIATIONS ON HEPATIC PHOSPHOLIPIDS. I. In Vivo Irradiation. Garcia Lopez, E.; Santiago, E. (Univ. Navarra, Pamplona, Spain). Rev. Clin. Espan.; 130: No. 3, 261-264(15 Aug 1973). (In Spanish).

The changes induced in vivo by x rays in rat liver phospholipids were studied. No immediate effect attributable to the irradiation was observed. However, the changes were manifested after incubation of liver homogenates. The most affected phospholipids seem to be phosphatidyl-choline and phosphatidyl-ethanolamine. No lipoperoxide formation was observed. These results and the fact of the finding of that 15.5% of total normal liver phospholipids are lyso-phosphatidyl-ethanolamine are commented on. (auth)

459 EPR STUDIES OF RADIATION EFFECTS IN PROTEINS. Crippa, P. R.; Vecli, A. (Univ., Parma, Italy). pp 549-556 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

A review of quantitative data on radiation effects in conjugated proteins is given. The main aim of the work was to try to organize all the experimental data in order to obtain a general view of this field. Special attention was given to the following phenomena: radiation protective role of prosthetic groups with high resonance energy; effect of the type of linkage between proteins and conjugated groups; role played by metal ions. A simple scheme of radical reactions is proposed which explains this last effect and, in particular, the inhibition of sulphur radicals by metal ions. (auth)

460 PREPARATION OF IMMOBILIZED ENZYMES BY γ-RAY IRRADIATION. Maeda, H. (Agency of Industrial Science and Tech., Chiba, Japan); Yamauchi, A.; Suzuki, H. Biochim. Biophys. Acta; 315: 18-21(1973).

Immobilized enzymes were prepared from acrylamide monomer only by means of γ-irradiation, a crosslinking reagent such as N,N'-methylenebisacrylamide being unnecessary. Glucoamylase, invertase, and β-galactosidase were each immobilized by this method. The rigid gel was prepared by using more than 2M (mega) rad of γ rays. The immobilized enzymes from the gel were detectable. (auth)

461 PHOTOCHEMICAL ATTACHMENT OF LAC REPRESSOR TO BROMODEOXYURIDINE-SUBSTITUTED LAC OPERATOR BY ULTRAVIOLET RADIATION. Lin, S. Y.; Riggs, A. D. (City of Hope National Medical Center, Duarte, CA). Proc. Nat. Acad. Sci. U. S. A.; 71: No. 3, 947-951(Mar 1974).

The transducing phage λh80dlac carries the lac operator, whereas wild-type λh80 does not. We find that in high salt (0.18 M KCl), ultraviolet radiation causes the formation of a very stable complex between repressor and 5-bromodeoxyuridine (BrdU)-substituted λh80dlac but not to BrdU-λh80 DNA. Studies with inducers of the lac operon confirm the specificity of attachment. In low salt (0.01 M KCl), ultraviolet radiation will also attach repressor nonspecifically to BrdU-λh80 DNA. The stability of the complex suggests that covalent bonds are formed. Another regulatory protein, the catabolite gene activator protein, can be attached similarly to DNA. (auth)

462 DNA REPAIR IN ESCHERICHIA COLI MUTANTS DEFICIENT IN DNA POLYMERASES I, II, AND/OR III. Tait, R. C.; Harris, A. L.; Smith, D. W. (Univ. of California, San Diego, La Jolla). Proc. Nat. Acad. Sci. U. S. A.; 71: No. 3, 675-679(Mar 1974).

E. coli mutants deficient in DNA polymerase I, in DNA polymerases I and II, or in DNA polymerase III, can efficiently and completely execute excision repair and post-replication repair of uv-damaged DNA at 43°C when assayed by alkaline sucrose gradients. Repair by cells deficient in polymerase I and in polymerases I and II is inhibited by 1-β-D-arabinofuranosylcytosine at 43°C, whereas that by cells deficient in polymerase III is insensitive to the inhibitor. When both DNA polymerases I and III are deficient, both excision repair and post-replication repair are greatly reduced at 43°C, and the residual repair capability is inhibited by 1-β-D-arabinofuranosylcytosine. Very little dark repair is observed in cells deficient in DNA polymerases I, II, and III, and the DNA is extensively degraded. These results suggest that either DNA polymerase I or DNA polymerase III is required for complete and efficient repair, and that when both DNA polymerases I and III are deficient, DNA polymerase II mediates a limited, incomplete dark repair of uv-damaged DNA. DNA polymerases I and III thus appear to be important enzymes in both DNA replication and DNA dark repair. (auth)

463 ENZYMATIC REPAIR OF DEOXYRIBONUCLEIC ACID; THE BIOCHEMICAL AND BIOLOGICAL REPAIR PROPERTIES OF A DEOXYRIBONUCLEIC ACID POLYMERASE FROM MICROCOCCUS LUTEUS. Hamilton, L.; Mahler, I.; Grossman, L. (Brandeis Univ., Waltham, MA). Biochemistry; 13: No. 9, 1886-1896(23 Apr 1974).

A DNA polymerase has been purified to homogeneity from Micrococcus luteus with a molecular weight of 100,000 to 110,000. In common with the Escherichia coli DNA polymerase I, it has associated 3' $\rightarrow$ 5' (single-stranded DNA) and 5' $\rightarrow$ 3' (double-stranded DNA) directed exonuclease activities. It has been shown capable of carrying out both the removal of pyrimidine dimers from incised uv-irradiated DNA (5' $\rightarrow$ 3' activity) and a controlled reinsertion of nucleotides into cavities in the DNA strand created by excision. Controllable biochemical conditions for these steps have been established using uv-irradiated DNA incised with a uv-endonuclease from M. luteus and model ^{32}P-labeled DNA templates excised with exonuclease III to form such cavities. The uv-endonuclease introduced a "nick" with a 3'-OH terminus into the uv-irradiated DNA adjacent to the pyrimidine dimer. The latter was removed by the DNA polymerase in the absence of synthesis (which restricted the 5' $\rightarrow$ 3' nuclease activity, and hence the size of the gap) in 15 min at 30° with 2 mm Mg^{2+}. Repair synthesis was carried out at 10°C in the presence of 0.5 mm Mg^{2+} and polynucleotide ligase. Biochemical repair of uv-irradiated Bacillus subtilis transforming DNA resulted in restoration of the single-strand molecular weight, and biological activity up to doses of 6.6×10^2 ergs/mm^2 (50% inactivation). (auth)

464 REACTIVITY OF THYMINE TO γ RAYS IN HELA CHROMATIN AND NUCLEOPROTEIN PREPARATIONS. Roti Roti, J. L.; Stein, G. S.; Cerutti, P. A. (Univ. of Florida, Gainesville). Biochemistry; 13: No. 9, 1900-1905(23 Apr 1974).

The radiation chemical reactivity of the thymine residues in the DNA of four nucleoprotein preparations from HeLa S3 cells was investigated: native chromatin; reconstituted chromatin; reconstituted DNA–histone complexes; and reconstituted DNA–non-histone chromosomal protein complexes. The γ-ray-induced formation of tritiated water from [Me-^{3}H]thymine was measured to assess the reactivity of the thymine methyl group. The formation of ringsaturated radiation products of the 5-hydroxy-6-hydroperoxydihydrothymine type was determined by selective degradation with alkali and acid. Linear dose–response curves were found in the low-dose region. It was found that the chromosomal proteins effectively protected the thymine residues from indirect radiation action, i.e., attack by radicals formed by water radiolysis, relative to free DNA. The relative reactivities for both reactions of thymine were: free DNA $\gg$ native chromatin $\approx$ reconstituted chromatin > reconstituted DNA-histone complexes > reconstituted DNA-non-histone chromosomal protein complexes. The observation that native and reconstituted chromatin was radiation chemically identical lends support to the notion that such preparations have similar or identical structural features. According to our results it appears unlikely that chromatin contains substantial portions of naked DNA. It is particularly interesting to note in support of recent chromatin models that the thymine residues were more reactive in chromatin than in reconstituted DNA-histone or DNA-non-histone chromosomal protein complexes despite the fact that chromatin contained about twice the amount of protein. (auth)

465 DAMAGE OF DNA BY ULTRAVIOLET RADIATION. Especially Two Adducts, PO-T and SP. Ikenaga, M. (Osaka

Univ.). Seibutsu Butsuri; 13: No. 1, 309-318(Jan 1973). (In Japanese).

Damage to DNA other than the production of pyrimidine dimers occurs owing to the physical condition and environment of the DNA and dose rate of ultraviolet ray in uv irradiation. In this paper, PO-T and spore photo-product are reported among the damage to DNA other than the dimer, properties which are well-known. Isolation and determination of the structure of the PO-T were successfully accomplished by Varghese and Wang in 1967, and the structure is 6-4'-(pyrimidine-2'-1)-thymine. The PO-T can be produced by the yield of 10 to 20% of the dimer, when aqueous solution of the DNA or cell suspension is irradiated by the uv ray at room temperature, namely under the condition often used for bioassay. Molecular weight of the refined PO-T is 220, and absorption spectrum in neutral or acid solution shows a peak at 316 nm. Mechanism and kinetics of the PO-T production, photolysis, and biological effect of the PO-T are explained. Noxiousness of the PO-T to living bodies and photochemistry of the DNA must be elucidated hereafter. The spore photoproduct is the uv damage proper to bacterial spores. It was discovered by Donnellan and Setlow in 1965, when the spores of B. megaterium were irradiated with the uv. When the dried DNA and frozen DNA solution are irradiated with the uv, the main product is also the spore photoproduct. Mechanism of the SP production and biological effect of the SP are explained. It is expected that studies on the molecular mechanism of spore mending and enzyme system will develop hereafter. (JA)

466 EFFECT OF COBALT-60 γ-RADIATIONS ON THE BIOLOGICAL ACTIVITY AND SOME PHYSICAL AND CHEMICAL PROPERTIES OF OXYTETRACYCLINE. Gupta, K. G.; Vyas, K. K.; Bhatnagar, L.; Sekhon, N. S. (Panjab Univ., India). Experientia; 30: No. 1, 108-109(15 Jan 1974).

Oxytetracycline was irradiated at doses of 5, 10, and 15 mrad in three different samples each. A table is presented to show effects of radiation on the activity of oxytetracycline on Staphylococcus aureus and Escherichia coli at the stated levels. The antibiotic activity against both organisms was completely lost at the 15 mrad dose. Marked changes in pH and color were also detected. Absorption spectra studies indicated gross changes in the molecular organization of the compound following irradiation at the higher dose. (HLW)

467 EFFECTS OF IONIZING RADIATIONS ON POLYRIBOADENYLIC ACID AND ITS CONSTITUENTS, AND DEPENDENCE OF RADIOSENSITIVITY ON SECONDARY STRUCTURE. Barszcz, D.; Shugar, D. (Univ. of Warsaw). Acta Biochim. Pol.; 19: 25-42(1972).

Radiochemical yields were determined for the destruction of adenine (G_a) and ribose (G_r) in free adenine and ribose, adenosine, adenosine monophosphates, as well as in two structural forms of polyriboadenylic acid (poly A), viz. the neutral single-stranded, and the acid twin-stranded, forms. The results were used to determine the dependence of radiation sensitivities of the various components in poly A on its secondary structure. The effect of irradiation on polynucleotide structure was followed by means of the temperature-induced helix-coil transition. Irradiations were performed in 0.005 M-acetate buffer, pH 5, which is equivalent to a monoradical OH· system. The values of G_a were found to be quite uniform in all the above compounds; but G_r decreased even in the nucleoside, to attain a value more than one order of magnitude lower in acid twin-stranded poly A. In acid poly A, G_r increases with radiation dose, testifying to the influence of secondary structure on the course of radiolysis of the polymer. Temperature-induced helix-coil transition profiles of poly A made it feasible to examine the influence of relatively low doses (as low as 2 kR) on the secondary structure. Radio-induced modifications of the structure of poly A are dependent on the conformation and the presence or absence of oxygen. Measurements of G values demonstrated that radiolysis of adenine most affected secondary structure up to doses of 10 kR. Radiolysis of ribose intervened at highest doses. The value of G_a for adenosine mononucleotides is markedly dependent on the position of phosphorylation. Phosphorylation on the $C_{(3')}$ or $C_{(5')}$ positions markedly protects adenine. Citrate buffer, commonly used as a standard solvent for following helix-coil transitions in nuclei acids, was found to exhibit a pronounced radioprotective effect on poly A. This is related to radiation-induced effects on citrate, which are reflected in changes in uv absorption of the buffer. (auth)

Radiation Effects on Cells

Refer also to abstracts 464, 486, 495, 534, 560, 604, 683, and 2306.

468 (ORNL-tr-2810) MARKED CHROMOSOME ASSOCIATIONS IN MONKEYS. II. The Association Frequency and Quantitative Analysis of Nucleoli in Cultured Lymphocytes Before and After the Anti-Lymphocyte Immunoglobulin Treatment. Dzhemilev, Z. A.; Verbitskii, M. Sh.; Shatalova, I. N. Translated by M. Gerrard from Tsitologiya; 25: No. 9, 1130-1134(1973). 6p. Dep. NTIS $4.00.

In cultured peripheral blood lymphocytes of Macaca mulatta, the frequency of cells with nucleolus-organizing chromosome associations was studied along with the number of nucleoli before and after anti-lymphocyte immunoglobulin treatment of the animals. After the treatment, the frequency of metaphases with marked associations and the number of blastoid cell with one nucleolus (small lymphocytes) decreased sharply in peripheral blood lymphocyte culture. The immunosuppressive action of the anti-lymphocyte immunoglobulin may be accounted for by this phenomenon. The frequency of cells with marked chromosome associations and the number of small lymphocytes with one nucleolus are suggested as cytogenetic and cytological tests in immunology. (auth)

469 QUANTITATIVE DESCRIPTION OF THE CELL RADIATION INACTIVATION. IV. Postirradiation Recovery of the Cell Viability With Division Delay. Barsukov, V. S.; Malinovskii, O. V. (Inst. of Nuclear Physics, Gatchina, USSR). Tsitologiya; 16: No. 1, 68-73(Jan 1974). (In Russian).

The postirradiation recovery of cell viability is regarded in terms of the cytogenetical model of radioinactivation. The increase in survival of cells treated between the irradiation and the first postirradiation mitosis may be due to a reduced lethal fixation probability, rather than to the repair of sublethal and potentially lethal radiation injuries. The cytogenetical model of radioinactivation fits well the experimental data. (auth)

470 ULTRASTRUCTURAL CHANGES IN THE PLASMATIC MEMBRANE OF CELLS UNDER PATHOLOGICAL CONDITIONS. Lebkova, N. P. Arkh. Patol.; 35: 25-32(1973). (In Russian).

Ultrastructural changes in the plasmatic membrane of parenchymatous and endothelial cells of the myocardium, liver, and thyroid gland under various pathological conditions (diabetes and its combination with additional affections, irradiation, nephrotoxic nephritis of Mazuguy as well as paragangliomas and insulomas) were studied. The changes were in the form of ruptures, fragmentation, loosenings of the plasmalemma, and its exfoliations from the cell's surface. They can be seen in the cells with a slightly changed structure of other organelles, and are related to the primary character of changes in the plasmalemma. A possibility of penetration of organelles from cells with a damaged membrane into interstices and capillaries and the entrance by this way of cellular antigens and enzymes into the blood flow and lymphs was put forward. Restoration of the plasmalemma in the cells of the myocardium in Alloxan diabetes is shown. (auth)

471 TIME-LAPSE PHOTOGRAPHIC STUDIES OF PEDIGREES OF X-IRRADIATED HeLa CELLS. Sasaki, H. (Kyushu Univ., Fukuoka). J. Radiat. Res.; 14: No. 3, 248-257(Sep 1973).

Pedigrees of HeLa S 3 cells irradiated with 300 rads of x rays were studied by time-lapse photography. The pedigrees were analyzed by classifying the cells as surviving and nonsurviving groups. In both groups a high degree of synchrony in division was observed after a division delay. In the nonsurviving group, loss of cells occurred in a synchronous fashion. Generation time was restored to nearly normal in the 1st postirradiation generation, but prolonged in succeeding ones. Division probability in the surviving group approached unity (0.9 to 1.0) except for a slightly reduced value (0.74) at the 3rd generation. In the nonsurviving group, the division probability was relatively high in the irradiated and the 1st generations (0.76), but declined from the 2nd to 4th generations with a progressive increase in cell damage, such as fusion and death. (auth)

472 ANALYSES OF DIFFERENTIAL SENSITIVITIES OF SYNCHRONIZED HeLa S 3 CELLS TO RADIATIONS AND CHEMICAL CARCINOGEN DURING THE CELL CYCLE. I. Establishment of Optimum Conditions for Obtaining a Large Highly Purified Synchronized Population. Watanabe, M.; Horikawa, M. (Kanazawa Univ., Japan). J. Radiat. Res.; 14: No. 3, 258-270(Sep 1973).

Optimum conditions were established for a combination of colcemid (0.025 μg/ml for 6 hours) and harvesting techniques in order to obtain a large highly purified population of mitotic HeLa S 3 cells. This method does not cause any visible biological or cytological damage to cells. The mitotic phase and the late G_1 to the early S phase of HeLa S 3 cells synchronized by this method were found to be more sensitive to x irradiation of 400 R than were the other phases in the cell cycle. Sensitivity to uv irradiation of 100 ergs/mm^2 increased late in the G_1 phase, reached a maximum in the middle of the S phase, and decreased through the remainder of the S and G_2 phases. In addition, the mitotic phase was as sen-

sitive to uv irradiation as the middle of the S phase. On the other hand, sensitivity to 4-NQO-treatment with 5×10^{-9} M for 20 min decreased from the late S to the early G_2 phase. All other phases were relatively sensitive to 4-NQO. These findings may indicate that the effects of x-, uv irradiation and 4-NQO on HeLa S 3 cells differ qualitatively from each other. (auth)

473 LONG-LIVED UV AND X RAY REACTIVATION OF A HUMAN VIRUS. Bockstahler, L. E.; Lytle, C. D. (Bureau of Radiological Health, Rockville, MD). pp 357-361 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

The survival of uv-irradiated virus is known to increase following exposure of host cells to low doses of uv light. This phenomenon is called uv reactivation. A similar effect, called x ray reactivation, occurs when cells are x-irradiated before infection with uv-irradiated virus. Using a human virus-mammalian cell system, it was determined if uv and x ray reactivation still occur when uv-irradiated viruses are inoculated at times later than immediately following irradiation of host cells. It was found that both phenomena are relatively long-lived. (auth)

474 PERMEABILITY AND EPR STUDIES ON HUMAN ERYTHROCYTE MEMBRANE SUBJECTED TO GAMMA IRRADIATION. Leyko, W.; Koter, M.; Domicz, U. (Univ., Lodz, Poland). pp 413-417 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

Studies on the effect of gamma irradiation on isolated erythrocyte membranes and whole blood were carried out. Membranes were investigated by the EPR method. In the case of whole blood degree of hemolysis and nucleotides content were estimated. Maximal free radical increase was observed at 120 krads, beginning of changes in ATP content in the range of 140-240 krads, distinct hemolysis in the range of 500 krads, and complete hemolysis at dose of about 1000 krads. (auth)

475 MECHANISMS OF NATURAL RADIOSENSITIVITY OF MAMMALIAN CELLS CULTURED IN VITRO. Parhomenko, I. M.; Bekeneva, G. P. (Moscow State Univ.). pp 179-183 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

Using two established cell lines, SOC and MIO, and synchronously-dividing SOC cells, it was shown that natural cell radiosensitivity of different cell lines and its variation during the cell cycle correlate with SH-groups level and antioxidant content in cells. The repair ability of both cell lines was found to be well pronounced and nearly equal. It is suggested that both of the investigated biochemical factors — SH-groups level and lipid antioxidants content — play an important role in natural cell radiosensitivity and its variation during the cell cycle. (auth)

476 DNA-REPAIR IN PERIPHERAL LEUCOCYTES OF LUPUS ERYTHEMATODES. Altmann, H.; Dolejs, I.; Eberl, R. (Oesterreichische Studiengesellschaft Fuer Atomenergie GmbH, Seibersdorf). pp 143-147 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971). (In German).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

CaCl density gradient centrifugation was used for DNA-repair after uv-irradiation in leucocytes of patients with Lupus erythematodes and control persons. Repair synthesis in leucocytes decreased in all investigated patients. DNA-antibodies were determined using ^{14}C-DNA and correlated to the repair replication. Viral etiology of LE was discussed in connection with decreased repair capacity and immunoenhancing effect of viruses in production of autoantibodies. (auth)

477 INFLUENCE OF SMALL DOSES OF RADON RADIATION AND ITS DAUGHTER PRODUCTS ON THE INCREASE OF BIOMASS AND OXYGEN CONSUMPTION LEVEL OF THE PARENT CULTURE. Rekkandt, A. A.; Dobrachev, Yu. P. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; No. 3, 243-246(1973). (In Russian).

Tissue was cultured in media having radon at an activity of 3.6×10^{-4} to 3.6×10^{-2} microcuries/ml (about 0.1 to 100 rads respectively). The total biomass in all cases increased from 15 to 100% during the first 3 days and all but the most radioactive sample increased during the 4th and 5th days. The data points are widely scattered, however, and show no obvious trend with either time or radiation dose. For some increases in the biomass, the number of cells remained constant. The oxygen consumption showed a more consistent trend: decreasing rapidly on the first day in an amount relative to the radiation dose, continuing the trend the second day, and essentially leveling off or, for the higher doses, increasing slightly such that the values lay rather close together by the 3rd day. Although the latter values were similar, the trend of decreasing O_2 with increasing radiation continued. The stimulation of the culture is related not only to phase adaptation but also to an increase in the number of dividing cells. (JPRS)

478 RADIATION RESPONSE OF L1210 LEUKEMIA CELLS PRETREATED WITH VITAMIN A ALCOHOL. Brandes, D.; Rundell, J. O.; Ueda, H. (Baltimore City Hospitals). J. Nat. Cancer Inst.; 52: No. 3, 945-949(Mar 1974).

Vitamin A (alcohol) pretreatment of L1210 leukemia cells in vivo enhanced the antitumor effects of x irradiation. This effect of the vitamin was dose and time dependent. For a given dose of x rays, maximum inhibition of reproductive capacity and survival of the leukemic cells were observed in culture pretreated 4 hrs with the vitamin. In combined x ray and vitamin A treatments, maximal inhibition of reproductive capacity and survival, as compared with treatment with x rays alone, occurred with a 4-hour vitamin A pretreatment. As this period of 4 hrs coincided with the peak of lysosomal enzyme release induced by the vitamin, a function for acid hydrolases in tumor-cell killing by x rays was postulated. From these results, however, it was not clear whether the effect of vitamin A in tumor-cell killing was additive or whether a true sensitization to radiation also took place. (auth)

479 DIFFERENTIAL EFFECT OF IONIZING RADIATION ON MAMMARY TUMOR VIRUS ACTIVITY ASSOCIATED WITH BLOOD CELLS AND MAMMARY TUMOR CELLS. Nandi, S.; Helmich, C. (Univ. of California, Berkeley). J. Nat. Cancer Inst.; 52: No. 4, 1271-1275(Apr 1974).

Studied were the effects of different doses of x rays and γ rays on mammary tumor virus (MTV) activity associated with blood, bone marrow, and mammary tumor cells. Irradiation with doses as high as 5000 and 10,000 rads had no adverse effect on MTV activity associated with mammary tumor cells or cell-free extracts of mammary tumors. In contrast, MTV activity associated with blood or with bone-marrow cell colonies in spleen (BMCCS) was inactivated at radiation dose levels of ≥1100 rads. The inactivation of BMCCS, or blood cell-associated MTV, could not be accounted for by a delay in its appearance in the peripheral circulation, nor were the results affected by the use of test mice with highly stimulated mammary glands for the MTV assay. These results provide a simple method for selective destruction of MTV activity associated with blood cells and suggest that cell division might be a prerequisite for the expression of the MTV activity in these cells. (auth)

480 EVIDENCE AGAINST A DIRECT CARCINOGENIC EFFECT OF X-RAYS IN VITRO. Klein, J. C. (Radiobiological Inst., Rijswijk, Netherlands). J. Nat. Cancer Inst.; 52: No. 4, 1111-1116(Apr 1974).

The carcinogenic effect of a single 300-rad dose of rays on cells of nonmalignant established mouse cell lines was investigated. Malignant transformation was induced in some lines under certain conditions; e.g., low viability, high cell concentration resulting in close contact between viable and nonviable cells, and cell debris. The same amount of cell damage caused by the radiation was mechanically induced and resulted in a comparable incidence of malignant transformation. This supports the hypothesis that the carcinogenic effect of irradiation on cells is related to the presence of dead and damaged cells in close contact with viable cells; it argues against a direct carcinogenic effect of radiation on cells. (auth)

481 THIRD COMPLEMENTATION GROUP IN XERODERMA PIGMENTOSUM. de Weerd-Kastelein, E. A.; Keijzer, W.; Bootsma, D. (Erasmus Univ., Rotterdam). Mutat. Res.; 22: No. 1, 87-91(Jan 1974).

Unscheduled DNA synthesis was studied following ultraviolet light exposure of parental and fused cell populations using two different types of classic xeroderma pigmentosum; using a moderately severe classic and a DeSanctis-Cacchione form of xeroderma pigmentosum; and using cells of two related patients both classic moderately severe cases of xeroderma pigmentosum. It was concluded that a third complementation group in XP is represented by the XP_1RO and XP_3RO cell strains which show intermediate levels of unscheduled DNA synthesis. (HLW)

482 RELATIONSHIP BETWEEN CHROMOSOMAL ABERRATIONS, SURVIVAL, AND DNA REPAIR IN TUMOUR CELL LINES OF DIFFERENTIAL SENSITIVITY TO X-RAYS AND SULPHUR MUSTARD. Scott, D.; Fox, M.; Fox, B. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Mutat. Res.; 22: No. 2, 207-221(Feb 1974).

A pair of cultured rat lymphosarcoma cell lines (Yoshida) with a pronounced differential sensitivity to killing with sulphur mustard (SM), but with the same sensitivity to x rays, was examined for chromosome damage and DNA repair replication after treatment with these agents. A pair of mouse lymphoma cell lines (L5178Y) with a differential sensitivity to x rays was similarly investigated. SM-resistant Yoshida cells suffered much less chromosome damage than sensitive cells in spite of equal alkylation of DNA, RNA and protein in sensitive and resistant cells. The pair of Yoshida cell lines sustained the same amount of chromosome damage after x-irradiation. Much less chromosome damage was observed in the radiation-resistant lymphoma cell line than in the sensitive line after x-irradiation. No difference was found between the pairs of cell lines in their capacities for repair replication after SM or x-ray treatment. Thus, the drug and radiation resistance is accompanied by, and perhaps mediated through, a reduced amount of induced chromosome damage but is not quantitatively related to the capacity for DNA repair replication. Apart from small differences in modal chromosome numbers there are no obvious karyotype differences between the sulphur mustard-sensitive and -resistant Yoshida cells or between the radiation-sensitive and -resistant lymphoma cells. (auth)

483 UV-INDUCED CHROMATID ABERRATIONS IN CULTURED CHINESE HAMSTER CELLS AFTER ONE, TWO, OR THREE ROUNDS OF DNA REPLICATION. Ikushima, T.; Wolff, S. (Univ. of California, San Francisco). Mutat. Res.; 22: No. 2, 193-201 (Feb 1974).

Synchronized G_1 or G_2 Chinese hamster cells were irradiated with uv light or x-rays and analyzed for chromosomal aberrations after one, two, or three replications. The cells were treated with Colcemid to induce polyploidy so that 2N, 4N, and 8N cells were scored. UV irradiation of G_1 cells induces mainly chromatid aberrations, whereas x rays induce chromosome aberrations. After both types of radiation chromatid aberrations appear in the polyploid cells. These results can be interpreted as indicating that uv and x rays induce lesions at the subchromatid level that cannot be expressed until one or two replications have occurred. Since uv can induce long-lived lesions, the uv data do not allow us to choose between mononemic and polynemic models of the chromosome. X-rays, however, are ionizing radiations that might not produce long-lived lesions. The x-ray data, therefore, are more easily interpretable in terms of lesions being induced in the subunits of a polynemic chromosome. (auth)

484 ADVANCES IN RADIOBIOLOGY AND EXPERIMENTAL HEMATOLOGY IN THE ASPECTS OF AVIATION AND SPACE MEDICINE. Szmigielski, S.; Kwarecki, K. (Military Inst. of Aeronautics Medicine, Warsaw). Postepy Astronaut.; 5: No. 1, 29-41 (1972). (In Polish).

Some new concepts on the cellular effect of ionizing radiation, including disturbances in mitoses and nucleic acid synthesis are presented. The possibility of the use of chemical agents protecting cells against radiation injury is discussed. Selected modern techniques in experimental and clinical hematology, permitting more precise evaluation of radiation injury and regeneration of bone marrow are discussed. (auth)

485 INHIBITION OF MESSENGER RNA ACCUMULATION BUT NOT TRANSLATION IN ULTRAVIOLET-IRRADIATED HEPATOMA CELLS. Bushnell, D. E.; Yager, J. D. Jr.; Becker, J. E.; Potter, V. R. Biochem. Biophys. Res. Commun.; 57: No. 3, 949-956 (8 Apr 1974).

Irradiation by ultraviolet light at doses between 30 and 90 ergs/mm^2 increasingly inhibited the hydrocortisone but not the insulin induction of tyrosine aminotransferase activity in Reuber (H35) hepatoma cells in culture. Incorporation of leucine into cellular protein was only slightly inhibited in this dose range. Incorporation of uridine into RNA in the presence of low doses of actinomycin D (0.1 μg/ml) was increasingly inhibited by ultraviolet irradiation. Since cellular uptake of uridine into the acid soluble pool was not inhibited by ultraviolet irradiation, the inhibition of RNA labeling suggests inhibition of synthesis of heterogenous nuclear RNA by low doses of ultraviolet irradiation. "Unscheduled" DNA synthesis was initially stimulated 2 fold by 30 ergs/mm^2 irradiation and returned to control levels in 8 hours. Thus, ultraviolet irradiation in the low dose range causes DNA repair synthesis, inhibits transcription and apparently tyrosine aminotransferase messenger RNA accumulation while pre-existing cytoplasmic messenger appears not to be inactivated nor its translation inhibited. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 461–463, and 465.

486 (SU-326-P-32-X-4) STUDIES ON THE REPAIR OF DAMAGED DNA IN BACTERIOPHAGE, BACTERIAL, AND MAMMALIAN SYSTEMS. Progress Report. (Stanford Univ., Calif. (USA). Dept. of Pathology). 15 Mar 1974. Contract AT(04-3)-326. 46p. Dep. NTIS $5.50.

Studies were conducted on the T4 UV endonuclease with regard to the following: purification and characterization; polarity of endonucleolytic incision with respect to dimers; chemistry of the termini at nicks; and degradation of single-stranded uv-irradiated DNA. Studies on the use of T4 UV endonuclease as a pyrimidine dimer probe in DNA included the following: DNA repair in mitochondria; dimer clustering in opposite strands of bacteriophage DNA; attempts at complementation of xeroderma pigmentosum cells in culture by T4 phage infection; and DNA sequencing studies. Studies on post-endonucleolytic excision of dimers in phage T4-infected cells included the following: the T-phage induced dimer excision nuclease; dimer excision activities in uninfected cells; other T4 genes and the role of host genes in T4 DNA repair; and measurement of thymine dimers in acid-precipitable DNA. Studies with mammalian cells included thymine dimer excision in vivo; dimer excision in cell-free preparations; and mitochondrial DNA repair. (HLW)

487 EFFECT OF X RAYS AND INHIBITORS OF PROTEIN SYNTHESIS ON THE SYNTHESIS OF CHLOROPHYLL AND NADP-LINKED GLYCERALDEHYDE 3-PHOSPHATE DEHYDROGENASE IN GREENING EUGLENA GRACILIS. Theiss-Seuberling, H. B. (Univ., Wuerzburg, Ger.). Arch. Mikrobiol.; 92: No. 4, 331-344 (1973). (In German).

The effect of x irradiation on the synthesis of chlorophyll and NADP-linked glyceraldehyde 3-phosphate dehydrogenase (GAP-DH) was investigated in resting cells of Euglena gracilis grown in the dark for two to three weeks only and, after x irradiation, exposed to light for three days. The D_{37} of chlorophyll synthesis was at 65 Krad and the D_{37} of enzyme synthesis at 45 to 50 Krad. The D_{37} of both is still very low, because it is only three times higher than the D_{37} of cell division. In contrast to the sensitivity of enzyme synthesis, the enzyme activity once being formed is very resistant to x irradiation. The radiosensitivity of NADP-linked GAP-DH synthesis differs significantly from the extreme resistance of the short time activation of NADP-linked GAP-DH to x rays, as demonstrated in Ankistrodesmus braunii. A short-time activation of this enzyme was not detectable in Euglena. Experiments were done with inhibitors of transcription: actinomycin C and D, 5-fluorouracil, and rifampicin. These inhibitors had no effect on the synthesis of chlorophyll and only slightly inhibited the synthesis of NADP-linked GAP-DH; the experimental values were always calculated on the basis of cell number. We therefore assume that there is enough messenger and precursor material in the organisms to permit the syntheses after the onset of light and that x rays cannot have affected transcription. The inhibitory effect of x rays is then assumed to have another cause. Chloramphenicol revealed a strong inhibition of both, the synthesis of chlorophyll and NADP-linked GAP-DH. Whether translation is affected by x irradiation or some other metabolic pathway, e.g., the combination of enzyme subunits, has to be clarified by further investigations. (auth)

488 STUDIES ON THE FUNGAL AMYLASES. II. Enzymatical and Morphological Variations by Ultraviolet Irradiation. Kurushima, M. (Matsutani Chemical Industry Co., Ltd., Japan); Fujii, T.; Kitahara, K. Nippon Nogeikagaku Kaishi; 46: No. 7, 361-365 (Jul 1972). (In Japanese).

Survivors of ultraviolet-irradiated Aspergillus cinnamomeus IAM 2040 were picked up. Most of them were similar to the parent strain in the activity of acid-stable α-amylase, which was mainly investigated in this study. Only a few strains were found to be changed in enzyme activity. Mutant No. 7117 obtained by four repeated selections by irradiation was observed to be fortified to 6 folds in the acid-stable α-amylase. Not only the amylase activity, but some other properties were also observed to be changed. (auth)

489 EFFECT OF IONIZING RADIATION ON ENZYMES. Radola, B. J.; Delincee, H. (Inst. of Radiation Tech., Karlsruhe, Ger.). Ann. Technol. Agr.; 21: No. 3, 473-486 (1972).

From 13th symposium of the International Commission of the Agricultural and Food Industries on the utilization of enzymes in these industries; Paris, France (14 Feb 1972).

The enzymological aspects of the effects of ionizing radiations on food have as yet received little attention. For a number of food products, the high residual activity of the enzymes presents an obstacle to the use of radiations for this purpose, as a result of undesired and uncontrolled post-irradiation effects. At present, currently feasible irradiation doses are insufficient to inactivate enzymes in foods. A combined irradiation/heat treatment seems to be the most promising approach. In order to gain a better

understanding of the molecular processes resulting from radiation, heat, and combined radiation/heat treatments, studies were effected on representative models. The changes in the charge and size characteristics of horseradish peroxidase were studied using thin layer isoelectric focusing and thin layer gel filtration. Different isoelectric patterns were observed after irradiation and after heat treatment. Enzymatically active aggregates were found after irradiation, but not after heat treatment. A synergistic effect was observed to occur when an irradiation-heating sequence was adopted, and an additive effect, when a heating-irradiation sequence was adopted. Experiments on sarcoplasmic proteins from irradiated beef demonstrated that the in-situ inactivation processes proceed in a similar way. (FR)

490 MUTATIONAL VARIABILITY OF VERTICILLIUM DAHLIAE KLEB. INDUCED BY ^{60}Co GAMMA RAYS. Kas'yanenko, A. G.; Portenko, L. G. (Inst. of Physiology and Biophysics of Plants, Tadzhik, USSR). Dokl. Akad. Nauk Tadzh. SSR; 16: No. 12, 55-58(1973). (In Russian).

Two-week old fungus cultures were irradiated with doses of 20, 40, 60, 80, 160, and 320 kR and the mutation yield was determined. The number of mutations increased with the dose. Morphological, physiological, and pigmental mutations were observed. The majority of the mutations were less virulent for cotton plants than the original forms. (JSR)

491 EFFECT OF GROWTH ON THE DISTRIBUTION OF RADIOLESIONS RESPONSIBLE FOR CYTOPLASMIC MUTATIONS (SMALL COLONY) IN YEAST. Heude, M.; Moustacchi, E. (Institut of Radium, Orsay, France). Compt. Rend., Ser. D; 277: No. 15, 1561-1564(15 Oct 1973). (In French).

Ultraviolet treated yeasts preserved in the dark in nonnutritive media can recover their mitrochondrial genotype if the radiation occurred during their exponential phase. In contrast, irradiation during the stationary phase leads to an aggravation of the cytoplasmic lesions. (FR)

492 RADIOINDUCED DIVISION DELAY IN TETRAHYMENA PYRIFORMIS. Sattler, E. L. (Univ., Giessen, Ger.). pp 337-341 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971). (In German).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

Radioinduced division delay in division-synchronized Tetrahymena cells, caused by x rays, photodynamic effect, and uv-light of 254 nm, is compared with delay induced by other means e.g., heat shocks and anoxia. There is a similar time pattern for x rays, photodynamic effect, and the mentioned nonradiation treatments. Starting from the end of synchronization treatment there is an increasing reaction until there is no more division delay. After uv treatment there is only a more or less constant division delay until the same time. The role of the so-called division-protein is discussed. (auth)

493 DNA REPAIR SYNTHESIS IN BACTERIA FOLLOWING UV IRRADIATION. Brozmanova, J. (Ustav Experimentalnej Onkologie Slovenskej Akademie Vied, Bratislava). Biologia (Bratislava); 28: No. 6, 481-487(1973). (In Slovak).

Current knowledge is reviewed of DNA repair replication and the so-called cut and patch repair is described. Experimental efforts are outlined dealing with the repair replication of DNA of Escherichia coli cells exposed to ultraviolet radiation. (INIS)

494 STIMULATION OF LYMPHOCYTES AND RUBELLA VIRUS. Najera, R. Rev. Sanid. Hig. Publica; 46: 327-333(May 1972). (In Spanish).

Rubella virus in cultures free from mycoplasms inhibits DNA synthesis in lymphocytes stimulated by phytohemagglutamines. Lymphocytes were stimulated for blasts formation but the number of those synthetizing DNA is reduced in presence of rubella virus. This effect can not be obtained by adding rubella neutralizing antibodies and it was reduced or totally eliminated by inactivation of the virus by uv irradiation. Addition of active or inactivated rubella virus to cells in phase of continuous division of two cellular lines of lymphoid origin, promoted an initial reduction of DNA synthesis which was followed, after two days, for increase of this synthesis. (auth)

495 CYTOLOGICAL AND CYTOGENETIC EFFECTS IN BACTERIAL AND MAMMALIAN CELLS DUE TO THE ACTION OF ACCELERATED HEAVY IONS. Grigor'ev, Yu. G.; Ryzhov, N. I.; Fedorenko, B. S.; Krasavin, E. A.; Vorozhtsova, S. V.; Koshcheeva, L. A.; Savchenko, N. Ya.; Khlaponina, V. F. Kosm. Biol. Med.; 8: No. 2, 3-8(1974). (In Russian).

Studies were performed with respect to the biological effectiveness of postradiation recovery processes and factors modifying radiological effects brought about by the action of heavy ions and standard radiations on bacterial E. coli B cells and mammalian cells. Heavy ions displayed a more pronounced biological effect. Bacterial and mammalian cells showed somewhat similar responses to radiations with high LET. This implied similarity in the trend and pattern of lesions. There were also significant qualitative and quantitative differences related to the species and organization of the biological objects tested. This referred mainly to the different relationship between the RBE changes and the LET. (auth)

496 RBE FOR HIGH-LET RADIATIONS WITH RESPECT TO MUTAGENESIS. ICRP Publication 18. Oxford; Pergamon Press (1972). 45p. £1.50.

A synthesis is presented of recent investigations on the mutagenic effectiveness of high LET radiations, which appear to be more effective for the induction of somatic radiation damage than low-LET radiations. It deals in turn with present and potential human exposures to high-LET radiation (cosmic and artificial sources); types and characteristics of the high-LET radiations used in mutagenesis research; studies on mutation induction on micro-organisms, fungi, higher plants, insects, experimental mammals, man; interpretation of results; relationship between linear energy transfer (LET) and relative biological effectiveness (RBE) and factors likely to influence that relationship (dose, dose rate and fractionation; sex, type of cell; oxygen; type of mutation). Applicability to man and implications for radiation protection are discussed. (Occup. Saf. Health Abstr.)

497 REPAIR OF DNA IN PULLULARIA PULLULANS AFTER ^{60}Co-IRRADIATION. Partsch, G.; Altmann, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf). pp 225-228 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

Investigations with the radioresistant yeast-like fungi Pullularia pullulans were performed to compare the sedimentation behavior of DNA originating from unirradiated and irradiated blastospores. The DNA of irradiated cells shifted to the lower density when it was centrifuged in an alkaline sucrose gradient. The cells exhibited the capacity to repair damage to DNA caused by irradiation, which could be indicated in the shift of the DNA peak after centrifugation to the density of the control if the cells were incubated for various times under definite conditions before irradiation. (auth)

498 INTERACTIONS OF IONIZING RADIATION AND UV-LIGHT ON DIPLOID YEAST. Schneider, E.; Kiefer, J. (Univ., Giessen, Ger.). pp 213-217 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

The interaction of ionizing radiation and uv-light on diploid yeast was investigated. The combinations of radiations with photoreactivation and delayed plating effect after pre-doses were carried out. The time between the two doses was kept as short as possible and was not varied. In the case of the interaction the shoulder of the survival curve disappears after low uv pre-doses completely. In the other case, however, a residual shoulder remains, even after high pre-doses. Photoreactivation and delayed plating effect are nearly always unchanged, even after pre-doses that reduce survival to few percent. (auth)

499 COMPARATIVE RADIATION SENSITIVITY OF FRESHLY ISOLATED AND LABORATORY STORED STRAINS OF SALMONELLAE. Todorov, S.; Minkova, M. Khranit. Prom.; 21: No. 6, 22-24(1972). (In Bulgarian).

In the comparison of the D_{10}-values between the corresponding fresh and cultivated strains of Salmonellae it is evident that laboratory cultivation decreases the radiation sensitivity of some strains and underlines the necessity for knowledge of radiation sensitivity in freshly isolated Salmonellae. The correct interpretation of the D_{10} values creates a basis for argumentation of the necessary dose for radiation of Salmonellae-containing food products. Thus in relation to the strains, contaminations with 10^{10} microorganisms would need doses of 90 to 300 Kp, and for contaminations with 10^{12} would be needed doses of 110 to 360 Kp. The conditionally accepted dose for meat and meat products treatment and radiation of the Salmonellae of 650 Kp is twice as high as the experimentally established one. It is ascertained that the difference in radiation sensitivity between fresh and laboratory strains is about 1000 fold. This shows what kind of hazards are to be encountered while practically elaborating the scheme for the radiation of meat products for Salmonellae, if all inferences

are based on data for irradiation of only laboratory strains. (INIS)

500 EFFECT OF ^{60}Co γ RAYS ON SALMONELLA TYPHI Ty2 CELL. Rhee, K. S.; Min, B. H.; Chang, C. S. Korean, J. Microbiol.; 11: No. 2, 79-88(1973).

In order to investigate the effect of gamma radiation on Salmonella typhi, Ty2, the components of amino acids, proteins, carbohydrates, and lipids in irradiated cells were compared with those in unirradiated control cells respectively. The results obtained were as follows: The inactivation curves of Salmonella typhi with ^{60}Co γ-irradiation were exponential over a wide range to the irradiated doses. Dose for the inactivation factor of 10^3 was 94.0 Krad in physiological saline or in phosphate buffered saline, 104.2 Krad in nutrient broth, 220.4 Krad in the frozen state, 552.0 Krad in the dried state, 88.3 Krad in the presence of an abundance of oxygen and 188.0 Krad in the absence of oxygen, respectively. Five consecutive irradiations of the Salmonella typhi suspension at a dose of 90 Krad gave no additional increase in resistance. Even at the smallest dose of 500 Krad, compositions of amino acids, proteins, carbohydrates, and lipids were more or less decreased and the distinct banding patterns were also lost possibly due to degradation of the protein molecules. (Korean Sci. Abstr.)

501 EFFECTS OF 5-BROMODEOXYURIDINE AND CAFFEINE ON THE RADIATION SENSITIVITY OF E. COLI B/r CELLS. Iyer, P. S. (Atomic Energy Dept., Trombay, India). Indian J. Biochem. Biophys.; 9: No. 3, 269-271(1972).

The presence of either 5-bromodeoxyuridine (5-BUDR) in the pre-irradiation growth medium or caffeine in the post-irradiation growth medium causes an increase in the radiation sensitivity of Escherichia coli B/r cells. When 5-BUDR-incorporate B/r cells are irradiated and then grown in nutrient agar containing caffeine, the effects of the two drugs on the radiation sensitivity of the cells appear to be additive. (Indian Sci. Abstr.)

502 B. TULARENSIS TOXICITY AFTER IRRADIATION WITH IONIZING RADIATION. Mescheryakova, J. S. (Inst. of Epidemiology and Microbiology, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol.; No. 3, 43-46(Mar 1973). (In Russian).

Data are presented on the toxicity of B. tularensis killed with ionizing radiation. The toxic component of the tularemia bacillus was very labile and was rapidly destroyed when stored as a suspension. Immune serum had an antitoxic action and protected white mice from death after administration of the irradiated suspension. A connection was demonstrated between the toxicity of B. tularensis, cells killed by irradiation, and the virulence of the strain. Administration of irradiated cells protected animals from death on subsequent infection with lethal doses of bacteria. The immunogenic activity was measured as an extension of the life of the experimental animals compared to the controls. (tr-auth)

503 ADVANCES IN STREPTOMYCES COELICOLOR GENETICS. Hopwood, D. A.; Chater, K. F.; Dowding, J. E.; Vivian, A. (John Innes Inst., Norwich, Eng.). Bacteriol. Rev.; 37: No. 3, 371-405(Sep 1973).

Since the last detailed reviews of the methodology and results of genetic studies with Streptomyces coelicolor, a number of advances in our understanding of genetic phenomena in this organism have been made. Most recent research has been in three areas: the fertility system; colonial differentiation; and the interactions between bacteriophages and streptomycetes. There have been some radiobiological studies and preliminary investigations of the genetic and biochemical organization of a few pathways. A number of improvements in the techniques of mutagenesis, mutant isolation, and genetic analysis have also been made. (auth)

504 MUTATION FIXATION IN MNNG-TREATED HAEMOPHILUS INFLUENZAE AS DETERMINED BY TRANSFORMATION. Kimball, R. F.; Setlow, J. K. (Oak Ridge National Lab., TN). Mutat. Res.; 22: No. 1, 1-14(Jan 1974).

A transformation assay was used to follow the fixation of mutations to novobiocin resistance induced by N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) in Haemophilus influenzae. Very few mutations are produced by recently treated DNA, but many are produced by the DNA from cells that have been incubated for a time after exposure to MNNG. The time course of this mutation fixation is shown to coincide reasonably well with the time course of semiconservative DNA synthesis, as judged by uptake studies and by isopycnic centrifugation of density-labeled cells. Incubation with bromodeoxyuridine (BrdUrd) during the fixation period decreases the number of mutations that are fixed, showing in another way the importance of DNA synthesis for fixation. Mutations fixed in the presence of BrdUrd are not more sensitive to 313-nm radiation than those fixed in its absence, suggesting that these residual mutations are fixed in the absence of extensive DNA replication. Mutations newly fixed in the absence of BrdUrd are much more sensitive to 313-nm radiation than are the same mutations some cell generations later. This shows that the newly fixed mutations are in a state that is different from their final form, either because they are in regions of DNA with special configurations of the strands or because they are in a region of DNA that is a hybrid between an old, alkylated strand and a new strand with some bases different from normal. The data suggest that it is unlikely that anything like all the mutations that are fixed in H. influenzae arise by direct action of MNNG on the replication fork. (auth)

505 THYMINE DIMER EXCISION IN UV-IRRADIATED AND 5-FLUOROURACIL-POSTINCUBATED ESCHERICHIA COLI. Brozmanova, J.; Sedliakova, M. (Cancer Research Inst., Bratislava). Folia Microbiol. (Prague); 19: No. 1, 12-15(1974).

The effect of post-irradiation cultivation with 5-fluorouracil on the excision of thymine dimers following uv irradiation was examined in Escherichia coli 15 $T^-U^-his^-$. An increase of the number of surviving cells caused by 60-min post-incubation with 5-fluorouracil was not accompanied by any more rapid and complete removal of thymine dimers from the damaged molecule of DNA. (auth)

506 EFFECTS OF OXYGEN ON X-RAY-INDUCED SINGLE-STRAND BREAKS IN EPISOMAL DNA ON LETHALITY IN ESCHERICHIA COLI. Johahsen, I. (Norwegian Defense Research Establishment, Kjeller). pp 349-355 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna, Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

The effects of oxygen on radioinduced cell death were compared with those on single-strand breaks in DNA. The frequency of x-ray induced DNA single-strand breaks was determined by measuring the production of the first break in closed circular superinfecting phage DNA. Under conditions of little repair the anoxic yield is 1.3×10^{-6} breaks per rad per 10^6 daltons, while under full oxygenation the yield increases to 4.4×10^{-6} breaks/rad/10^6. These values are threefold higher than previously published values. Oxygen is 3 to 4 times more effective on a molar basis in cell killing than in promoting DNA strand breaks. In cell killing oxygen can compete with tetramethylpiperidinol N-oxyl (TMPN) but in promoting DNA breaks there is no competition between oxygen and TMPN. These data suggest that the reactions of oxygen in DNA single-strand breakage are separate from those involved in cell killing. (auth)

507 DNA INHIBITORS AND CARCINOGENESIS: INHIBITION OF POST-UV IRRADIATION GROWTH IN THE DARK OF TETRAHYMENA PYRIFORMIS BY CAFFEINE AND THE ONCOGENIC MYCOTOXIN LUTEOSKYRIN. Mouton, R. F. (CEN de Saclay, Gif-sur-Yvette, France). pp 241-250 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Luteoskyrin, the oncogenic mycotoxine extracted from Penicillium Islandicum Sopp contaminating rice, inhibits post-uv irradiation growth of Tetrahymena pyriformis at sub-toxic concentrations for which multiplication or morphology of the non-irradiated ciliate is unaffected. $2.06 \cdot 10^{-7}$M Ls introduced in the post uv irradiation growth medium shows an anti-repair capacity equivalent to 1.10^{-3}M of caffeine. When added in vitro to the system calf thymus DNA Escherichia coli polymerase I, Ls but not caffeine inhibits repair polymerization. This suggests that Ls inhibits a late step of repair that caffeine does not affect. Oncogenicity of Ls may result from long term exposure of chromosomes to concentrations of the mycotoxin thus inhibiting spontaneous DNA repair function, fixing premutational damage leading eventually to cancerous transformation of the genome. The discovery that fibroblasts of patients suffering from the hereditary uv-inductible cancer Xeroderma Pigmentosum lack a specific functional repair enzyme, brings a genetical support to the hypothesis of a link between the anti-repair action of specific mycotoxins and cancer inductivity in man. (INIS)

508 ZINC TOXICITY IN IRRADIATED BACILLUS MEGATERIUM. Kiortsis, M.; Vrantzas, N. (Democritus Nuclear Research Centre, Athens). Experientia; 30: No. 1, 79-80(15 Jan 1974).

Cultures of B. megaterium were γ-irradiated at doses up to 26,000 rads and pre- and post-treated with zinc chloride. Effects of zinc on non-irradiated cultures were also studied. A synergistic effect of zinc and irradiation was observed for doses higher than

12,000 rads. The synergistic effect was more intense in a post-treatment with zinc than in a pre-treatment. (HLW)

509 UV-INDUCED REPLICATING INSTABILITY IN SCHIZOSACCHAROMYCES POMBE. Nasim, A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Mutat. Res.; 22: No. 1, 25-31 (Jan 1974).

A pigmented adenine-requiring strain of S. pombe was used to study some aspects of the uv-induced replicating instabilities in this yeast. The effect of the repair capacity of a cell on the frequency of such instabilities has been investigated by using three different radiation-sensitive mutants and by studying the influence of caffeine on the frequency of secondary mosaics. Data showed that uv-induced replicating instabilities are not influenced by changes in the repair capacity of the treated cell. Since two of the sensitive mutants used are known to have high spontaneous mutation rates and the third one shows reduced uv-induced mutability, the induction of replicating instabilities differs in this respect both from the induction of spontaneous and uv-induced mutations. (auth)

510 EFFECTS OF ULTRAVIOLET RADIATION ON CAROTENOID CONTAINING AND ALBINO STRAINS OF NEUROSPORA CRASSA. Morris, S. A. C.; Subden, R. E. (Univ. of Guelph, Ont.). Mutat. Res.; 22: No. 2, 105-109(Feb 1974).

To determine the influence of carotenoids on uv sensitivity of Neurospora crassa conidia, the dose-response curves of 3 albino strains were compared to that of the wild type. In a control experiment the genetic background effects were eliminated by irradiating the wild type in which carotenoid synthesis had been inhibited by β-ionone, and comparing the dose-response curve to that of untreated wild type. All strains used had similar γ survival curves and nuclei per conidium which precluded differences in uv sensitivity due to morphological differences. The albinos and β-ionone-treated strains showed a greater sensitivity (mean LD50 $4.35 \cdot 10^3$ erg/mm^2) to uv irradiation than the wild type (LD50 $7.30 \cdot 10^3$ erg/mm^2). (auth)

511 RADIATION DAMAGE TO CELL MEMBRANE AND LOSS OF VIABILITY IN E. COLI B/R. Misiti-Dorello, P.; Cancelliere, G.; Sapora, O.; Quintiliani, M. (Instituto Superiore di Sanita, Rome). pp 343-347 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

In Escherichia coli B/r potassium retentivity is less sensitive than survival to the effects of x rays and it is practically unaffected by the oxygen tension, whereas survival exhibits the well-known oxygen effect. NEM (N-ethylmaleimide) enhances the lethal effects of radiation, to a greater extent in anoxia, while it reduces the effects on K^+ retentivity both in anoxia and in the presence of oxygen. The sensitivity of bacteria to membrane damage by γ-rays can be increased by the previous exposure to such low doses of uv light that their sensitivity to damage responsible for loss of viability is not yet affected. (auth)

Radiation Effects on Plants

Refer also to abstracts 496, 2299, and 2301.

512 (TID-26554) SPECIAL BREEDING AND EVALUATION TECHNIQUES FOR SOYBEAN IMPROVEMENT. Koo, F. K. S. (Puerto Rico Nuclear Center, Mayaguez). 1973. Contract AT(40-1)-1833. 19p. Dep. NTIS $4.00.

This review covers the subjects on special breeding techniques such as mutation breeding, recurrent selection and use of hybrid vigor, and on special screening and evaluation techniques for disease and insect resistance, high protein, methionine and other S-containing amino acids, day neutrality, low photorespiration rate, and high seedling emergence at elevated temperatures. Greater attention is given to the discussion of the techniques most useful to the soybean improvement program in the tropics. (auth)

513 COMBINED EFFECT OF GAMMA RAYS AND ETHYLENIMINE (EI) ON CELLS OF CREPIS CAPILLARIS L. SEEDS TREATED AT THE PRESYNTHETIC STAGE OF THE MITOTIC CYCLE. Sidorov, V. P. (Inst. of General Genetics, Moscow). Genetika; 10: No. 1, 34-41(1974). (In Russian).

The combined effects of gamma rays and ethylenimine (EI) were studied. Dry seeds of Crepis capillaris L. served as a model for this study. They were treated at the G_1 stage of the mitotic cycle and the effect of treatment was traced through two successive cell divisions. The dose of gamma irradiation was 2 kh, the EI concentration was $4.6 \cdot 10^{-3}$ M. The combined effect on diploid metaphases was lower than additive. In case of separate treatment with each mutagen no newly formed aberrations were observed in the second cell division, while the simultaneous treatment with both mutagens resulted in the appearance of a considerable number of chromatid aberrations. The combined effect of gamma rays at a 2 kR dose and EI at a concentration of $9.3 \cdot 10^{-3}$ M was additive, while the combined effect of gamma rays at a dose of 2 kR and EI at a $2.3 \cdot 10^{-2}$ M concentration as well as that of gamma rays at a 10 kR dose and of EI at a $9.3\ 10^{-3}$ M concentration was superadditive. In the second cell division EI at concentrations $9.3 \cdot 10^{-3}$ M and $2.3 \cdot 10^{-3}$ M induced many aberrations of chromatid type, while in case of combined treatment the yield of chromatid-type aberrations is considerably higher than in the case of EI treatment alone. (auth)

514 REPAIR OF THE LESIONS AT DNA SYNTHESIS PHASE INDUCED BY IRRADIATING THE G_1 CHROMOSOMES OF BARLEY. Yamamoto, K.; Yoshida, H.; Yamaguchi, H. (Tokyo Univ.). Cytologia (Tokyo); 37: No. 4, 595-600(Dec 1972).

G_1 cells in primary roots of Hordeum vulgare were irradiated with ^{137}Cs γ rays at a dose of 198 R and centrifuged for 4 min at $1500 \times g$ at various time after irradiation. Post-irradiation centrifugation increased the frequency of anaphase fragments. The significant increase in frequency was found to be possible only before the progression of the irradiated cells from G_1 into S. The best hypothesis to account for the obtained results seems to be that the G_1 cell in the first mitotic cycle after seed germination does not contain the factor(s), probably enzyme(s), necessary to accomplish repair of radiation-induced lesions and also chromosome duplication. (auth)

515 SPECTROSCOPIC INVESTIGATION OF THE STRUCTURE OF CELLULOSE SEPARATED FROM COTTON WITH γ-IRRADIATED SEEDS. Zhbankov, R. G.; Marupov, R. M.; Ivanova, N. V.; Firsov, S. P.; Korolik, E. V. (Physical-Technical Inst., Tadzik, USSR). Dokl. Akad. Nauk Tadzh. SSR; 16: No. 12, 16-20 (1973). (In Russian).

The results of the spectroscopic study of fibers of cotton cellulose grown from seed γ-irradiated at doses of 32 and 56 kR. are reported. The comparison of the infrared spectra of the cellulose from irradiated seeds with cellulose from control plants shows that γ irradiation of cotton does not lead to a substantial change of the biosynthesis of cellulose in mutations of the first generation. (JSR)

516 DEPENDENCE OF RADIOSENSITIVITY ON CELLULAR PARAMETERS IN MERISTEMAL PLANT CELLS. Seibold, G.; Kiefer, J. (Univ., Giessen, Ger.). pp 449-453 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Baden; Wiener Medizinische Akademie (1971). (In German).

From 1st European biophysics congress; Vienna, Austria (14 Sep 1971).

The effects of x rays on root growth of 16 different plant species were investigated. On the basis of a mathematical model survival curves could be deduced for the meristem cells. The D_0 values varied from 25 to 600 rads. A linear relationship between radiosensitivity ($1/D_0$) and the interphase chromosome volume (ICV) shows a high correlation supporting results of some authors. An inverse correlation with results of other authors was found. An inverse correlation also was found to exist between DNA-content per chromosome and D_0 values. The amounts of energy absorbed per chromosome at D_0 calculated on the basis of ICV are 15 times greater than the values calculated on the basis of DNA content per chromosome. It is concluded that the values calculated on the basis of DNA content are more significant in cellular radiobiology because they offer some aspects of inactivation mechanisms. (auth)

517 EFFECT OF IRRADIATION ON STERILITY OF JOWAR SEEDS. Pokle, Y. S. (Coll. of Agriculture, Nagpur, India). Botanique (Nagpur); 3: No. 2, 93-97(1972).

Yellow seeded (improved Saoner) and White seeded (improved Ramkel) varieties of sorghum were irradiated with 10,000, 15,000, and 20,000 R units of γ rays and sown in the field for testing effects on pollen and grain sterility. Gamma rays were found to have the maximum effect on increasing the grain sterility in both the varieties. Maximum sterility occurs with 10,000 R in Saoner and at 15,000 R in Ramkel. The 20,000 R dose in both the varieties affected the sterility to a lesser extent. Study of pollen grain sterility follows the identical trend. A direct correlation between doses and sterility does not exist. (Indian Sci. Abstr.)

518 PHYSIOLOGICAL RESPONSE OF CHLAMYDOMONAS REINHARDTII DANG. CELLS TO TREATMENT WITH N-NITROSO-N-METHYLUREA AND ULTRAVIOLET RADIATION. Miadokova, E.; Podstavkova, S.; Thi Hoa, T. (Comenius Univ.,

Bratislava). Biologia (Bratislava); 28: No. 6, 451-462(1973). (In Slovak).

The effect of ultraviolet radiation alone and the effect of N-nitroso-N-methylurea applied in combination with a low dose of ultraviolet radiation were studied on the survival, on the number of zoospores produced during the first division, and on the lag phase of the cells of Chlamydomonas reinhardtii Dang. N-nitroso-N-methylurea and ultraviolet radiation in combination had a higher inhibitory effect on the nuclear and the cellular division than the chemical or the physical mutagen alone. This was shown by the reduction of multispore types and the extension of the lag phase. The combined application of N-nitroso-N-methylurea and ultraviolet radiation also resulted in a higher death rate. (auth)

519 MUTAGENIC EFFECT OF N-NITROSO-N-METHYLUREA APPLIED ALONE AND COMBINED WITH ULTRAVIOLET IRRADIATION ON CHLAMYDOMONAS REINHARDTII DANG. CELLS. Podstavkova, S.; Misokoc, W.; Rhi Hoa, I. (Comenius Univ., Bratislava). Biologia (Bratislava); 28: No. 6, 469-476 (1973). (In Slovak).

The effect was studied of various concentrations of N-nitroso-N-methylurea applied alone or combined with 10 seconds of ultraviolet irradiation on genetic changes (pigment mutations, morphological changes, microcolonies, lethal and double mutations) in Chlamydomonas reinhardtii Dang. cells. Additional irradiation of the cells previously treated with N-nitroso-N-methylurea was found to increase the mutagenic effect of the chemomutagen. (auth)

520 USE OF THE CYTOKININES OF MAIZE JUICE AND OF BENZYLADENINE IN RESTORING THE PROLIFERATION POWER OF NORMAL JERUSALEM ARTICHOKES TISSUES IRRADIATED WITH ^{60}Co γ RADIATION. Jonard, R.; Soler, A. (Univ., Montpellier, France). Compt. Rend., Ser. D; 277: No. 14, 1305-1307(8 Oct 1973). (In French).

Cytokinines extracted from the juice of young maize caryopses and benzyladenine both restore the proliferation of normal tissue in Jerusalem artichokes irradiated with ^{60}Co γ irradiation in the same way as kinetine. (FR)

521 EFFECT OF IONIZING RADIATION ON SEEDS OF VICIA FABA. Shepstone, B. J. (Groote Schuur Hospital, Cape Town). S. Afr. J. Sci.; 69: No. 7, 207-212(Jul 1973).

In the experiments performed, low doses of x rays to the dry seed did seem to have a stimulating effect on the subsequent growth rate of roots grown from them, compared with roots from unirradiated control seeds. There was no concomitant decrease in germination rate with dose. At higher doses the response was very similar to that obtained in the case of ordinary irradiated roots. As a result it has been possible to apply well known mathematical models of the root meristem to the radicle following acute irradiation, and a dose-response curve with respect to reproductive integrity has been derived. The effect of irradiation on the kinetics of the embryonic radicle meristem of Vicia faba is described, and a dose-response relationship with respect to reproductive integrity is derived. (INIS)

522 ISOLATION AND PROPAGATION OF THE MUTANT PLANT FROM SECTORIAL CHIMERA INDUCED BY IRRADIATION OF BEGONIA REX. Shigematsu, K.; Matsubara, H. (Tokyo Metropolitan Isotope Research Center). Engei Gakkai Zasshi; 41: No. 2, 196-200(Jun 1972). (In Japanese).

A possibility of the application of the cultural technique in vitro for the isolation, fixation, and propagation of the mutant plant from sectorial mutation induced by gamma irradiation in Begonia rex was investigated. The variety "Winter Queen" was employed throughout all the experiments. The leaf fragments sterilized anti formin were cultured in the plant growth cabinet at 25 ± 2°C, 40 to 50% relative humidity and 3000 lux illumination for 11 hrs a day. The adventitious buds that grew from the leaf fragments after a month of culture in vitro were irradiated with 10 krad of γ ray at a dose rate of 0.2 krad/hr. After irradiation, the leaf fragments were cultivated for another 3 to 4 months in the same cabinet. Then, the buds grew until the young plants produced several leaves. Two of the thirty young plants produced the chimeric variegations on their leaves. The leaf of chimeric plant has the sectors of green leaf color with silver white spots. Whereas the original leaf color of "Winter Queen" is covered with silver white. For the isolation and fixation of this somatic mutation, the sector of the leaf was cut into leaf fragments, and these fragments were planted onto White's agar medium. The fragments were cultured under aseptic conditions for 4 to 5 months in vitro. After a month, the adventitious buds arose from the leaf fragments cultured and grew to young mutant plant after another 4 to 5 months of the culture. Among these plantlets, three sound plants were transplanted to flower pots in the water culture bed in the green house. These new plants propagated from the mutant sector were changed wholly in leaf color as that of the sector. Some histological explanations on the development of wholly changed plant from leaf fragment were presented. From this investigation, it is suggested that the adequate combination of irradiation and of in vitro culture will be useful in the breeding of the horticultural crops. (auth)

523 VARIATION OF RADICALS OF POST-IRRADIATION STORAGE OF SINGLE CARYOPSES AND EMBRYOS OF WHEAT. Walther, F. (Kernforschungsanlage, Juelich, Ger.). pp 563-568 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

In intact dry seeds (5% H_2O) of wheat caryopses doses higher than 20 krad induce a complex broad EPR signal. This signal contains two "subsignals" the heights of which increase with dose linearly but at a different rate. Moreover, their signal heights differ in the type of change dependent on the previously applied dose and the duration of storage. In stored irradiated embryos, an increase of the radical amount was observed. Possible explanations for these results are discussed. (auth)

524 EFFECT OF PRE-SOWING EXPOSURE OF SEEDS TO GAMMA RADIATION ON THE DROUGHT RESISTANCE BEHAVIOUR OF BARLEY PLANTS (HORDEUM VULGARE L.). Garg, O. K.; Misra, B. C.; Singh, B. P. (Banaras Hindu Univ., India). Plant Soil; 36: No. 1, 39-45(1972).

To examine the effect of pre-sowing exposure of seeds to gamma radiation (3000 R) on the drought resistance behavior of Hordeum vulgare var. K_{12} plants, a pot culture experiment was conducted in a glass house. The plants were subjected to wilting treatments at tillering stage and were maintained for 10 days. Subsequently, observations on survival capacity, growth behavior, and physiological changes were made during the wilting period. The data obtained were subjected to statistical analysis. Reduction in soil moisture causes a set-back in the physiological status of barley plants and thereby inhibits the crop growth. Pre-sowing exposure of seeds to gamma radiation induced drought tolerance. It improved the growth behavior and also maintained an active metabolism in plants even under wilting condition. (Indian Sci. Abstr.)

525 INTER-UNIVERSITY JOINT USE OF GOVERNMENT NUCLEAR FACILITIES IN JAPAN. V. Co-ordinated Research Program on Radiation Breeding. Yamaguchi, H. (Tokyo Univ.). Nippon Genshiryoku Gakkaishi; 15: No. 2, 115-117(Feb 1973). (In Japanese).

A so-called "gamma field" is suitable for the irradiation on plant life under natural conditions at low doses in the research on mutations. Because of narrow land in Japan, a single gamma field was installed as a part of the National Institute of Agricultural Sciences, and it has been used jointly by educational institutions. Situated in Ibaraki Prefecture, the field is a circular farm-land of radius 100 m enclosed in protective embankment, with 3000 Ci ^{60}Co as the radiation source. Description is made on the inter-university joint use of the NIAS's gamma field and the research works made up to the end of fiscal 1971: namely, irradiation effects at low dose (stamen piles of spiderwort, etc.); radiation injuries of reproductive organs (rice and morning glory); and effects of radiation in agriculture (sweet potato, onion, mint). (JA)

526 CYTOGENETIC STUDIES ON THE EFFECT OF ^{60}Co GAMMA IRRADIATION ON VICIA FABA. Amer, S. M.; Mikhael, E. (National Research Center, Cairo). Cytologia (Tokyo); 37: No. 2, 169-174(Jun 1972).

Vicia faba seeds (var. Giza 1) were irradiated with: 500, 1000, 2000, 4000, 6000, 8000, and 10,000 R of ^{60}Co γ radiations. A rapid increase in the percentage of abnormal cells in root-mitosis was observed as the employed dose increased from 8000 to 10,000 R. The same doses affected a high degree of inhibition in root-growth. The change in the normal cells was proportional with the given doses. Micronucleated cells represented the most dominent type of anomalies affected by irradiation. Plants originated from irradiated seeds recovered. A significant percentage of abnormal PMC$_4$ was observed only in plants originated from seeds irradiated with 10,000 R. (auth)

527 EFFECT OF CHRONIC GAMMA RADIATION IN HYBRIDIZATION BETWEEN LYCOPERSICON ESCULENTUM AND L. PERUVIANUM. Yamakawa, K. (Inst. of Radiation Breeding, Omiya, Japan). Gamma Field Symp.; No. 10, 11-31(Mar 1973).

Radiation effects on the interspecific hybridization between Lycopersicon esculentum and L. peruvianum, which is resistant to many tomato diseases were investigated. Deleterious and beneficial effects of the radiation were found through experiment. Irradiation after meiosis including mature pollen irradiation had only deleterious effects. Prolonged chronic irradiation in-

cluding at least meiosis and in most cases all microsporogenesis from pollen-mother-cell differentiation to dehiscence had beneficial effect at suitable exposure rate, although the effect was deleterious at excessively high rate. It was presumed that the way by which the radiation acts beneficially was genetic rather than physiological from the finding that a larger number of well developed seeds were obtained from a single fruit when the irradiation was extended. The possibility that mutation was responsible for the effect was discussed. (JA)

528 SEQUENTIAL CAFFEINE-CYSTEIN TREATMENT AND ENHANCED RADIOPROTECTION OF VICIA FABA CHROMOSOMES. Balachandran, R.; Kesavan, P. C. (Jawaharlal Nehru Univ., New Delhi). Experientia; 30: No. 1, 91-92(Jan 1974).

Secondary roots of Vicia faba were subjected to a total dose of 200 R of gamma rays. Solutions of caffeine and cysteine were used separately and as mixtures for treating the roots before and after irradiation. Results showed that treatment with caffeine applied before irradiation and cysteine immediately afterwards gave greater protection than cysteine alone to chromosomes irradiated at the G1 stage. (HLW)

529 EFFECT OF GAMMA RADIATION ON THE FUNCTIONAL PROPERTIES OF RIBOSOMES IN COTTON PLANTS. Safarov, Sh.; Ibragimov, A. P. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 5, 7-10(1973). (In Russian).

The action of radiation on the functional properties of ribosomes in gamma-irradiated organisms and on isolated ribosomes was studied. With increase in the radiation dose, the uptake of labeled amino acids by ribosomes separated from the irradiated products and also on irradiation of isolated ribosomes decreased. The functional activity of ribosomes irradiated with different doses with the use of synthetic matrixes of field U and field A, synthesized polyphenylalanine, and polylysine was studied as a function of the radiation dose. The drop in activity of the protein-synthesizing system with high radiation doses is explained by the structural and functional changes in ribosomes and by interruption of the biosynthesis and function of information RNA. (tr-auth)

530 MUTATION OF THE WILT-RESISTANCE PROPERTY OF COTTON ON IRRADIATION OF THE POLLEN. Egamberdiev, A.; Abdullaev, T.; Mukhamedzhanova, D. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 5, 68-69(1973). (In Russian).

Studies on gamma (^{60}Co) irradiation of pollen of cotton indicated that such an irradiation carried out prior to cross-pollination may change the nature of the wilt resistance in the F_2 hybrid. Radiation doses used were 1 krad at a dose rate of 13 R/sec. (MG)

531 PROTEIN CONTENTS OF RADIATION MUTANTS OF COTTON AND THEIR INITIAL FORM IN ONTOGENESIS IN NORMAL SEEDS AND AFTER PRE-SOWING GAMMA IRRADIATION. Nazirov, N. N.; Ganiev, S. G. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 5, 11-15(1973). (In Russian).

In all types of cotton studied, the amount of albumins in the leaves increased with growth and development in plants from both normal and gamma-irradiated seeds. The irradiated plants of type 1306 DV and its mutant RL-1 differed from the controls in the high albumin and globulin contents. With irradiated seeds of wild cotton, as the day lengthened naturally the globulin content increased more than in the nonirradiated, and as the day shortened, the reverse was true. Under natural light conditions, as the day shortened, the amount of gluten decreased more in the irradiated plants than in the controls. With regard to the protein content of the leaves during ontogenesis and in sensitivity to radiation, the mid-season-maturing mutant FRM was intermediate between the initial wild form and the cultivated fast-maturing type 1306-DV and the mutant RL-1. (tr-auth)

532 ANALYSIS OF QUANTITATIVE AND STABILITY TRAITS IN SUCCESSIVE GENERATIONS OF RADIATED AND NONRADIATED BULK OAT POPULATIONS. Fatunla, T. Ames, IA; Iowa State Univ. (1973). 105p. University Microfilms Order No. 74-532.

Thesis (Ph.D.).

The materials for the study originated from F_2 seeds of several oat crosses that were subsequently divided into radiated and nonradiated lines of descent. The seeds of the radiated lines of descent were treated with thermal neutrons and x rays from F_4 to F_7, primarily to promote outcrossing; of course, these treatments also would induce mutations. In each generation of the radiated (F_4 to F_{11}) and nonradiated (F_3 to F_{12}) lines of descent 90,000 to 100,000 seeds were sown, respectively, and samples of seeds were saved in cold storage. From successive generations of the radiated and nonradiated lines of descent randomly selected seeds were increased in isolation to produce separate lines. In one experiment 40 lines from six generations (F_3, F_4, F_6, F_9, F_{10}, F_{12}) of the nonradiated line of descent and five generations (F_4, F_6, F_8, F_{10}, F_{11}) from the radiated line of descent were grown at Ames, Iowa to estimate changes in generation means and variances for grain yield, bundle weight, plant height, seed number per plot, heading date, 100-seed weight and harvest index. In a second experiment 20 lines from five generations (F_3, F_6, F_7, F_9, F_{12}) of the nonradiated line of descent and four generations (F_7, F_8, F_9, F_{11}) of the radiated line of descent were grown in 14 environments to estimate stability parameters for grain yield, seed number per plot, bundle weight, plant height and 100-seed weight. Both experiments were grown in hill plots using a randomized complete-block design. In the Ames Experiment, natural selection increased grain yield and seed number means in both the radiated and nonradiated lines of descent. In the experiment across 14 environments, improvement in yield and seed number occurred only in the radiated line of descent. In addition, improvement in the radiated line of descent was linear in both experiments, whereas that of the nonradiated was not. The mean regression stability index declined from 1.17 in F_3 to 1.04 in F_{12}, and increased from 0.82 in the F_7 to 1.02 in F_{11} in the nonradiated and radiated lines of descent, respectively. If b = 1.0 is assumed as a stable reaction, it was concluded that both lines of descent became more stable with advancing generations. Since the mean squares for deviations for the nonradiated line of descent were significant in each generation and those for the radiated one were not, it was concluded that the radiated line of descent was more stable than the nonradiated one. (Diss. Abstr. Int., B)

Radiation Effects on Animals

Man

Refer also to abstracts 107, 298, 318, 484, 496, 528, 727, 1782, 2000, 2210, and 2308.

533 (LIB/Trans-522) CHROMOSOME ABERRATIONS OF HUMAN LYMPHOCYTES AFTER X IRRADIATION IN VITRO. I. Qualitative and Quantitative Aspects of Dose-Response Relationships. Schmid, E.; Bauchinger, M.; Hug, O. Translated from Mutat. Res.; 16: 307-317(1972). 18p. Dep. NTIS (US Sales Only) $4.00.

Human peripheral lymphocytes were irradiated with different doses of 220 kV x rays. The frequency of different aberration types was determined and dose-response curves were constructed. The data were fitted by least squares regression analysis to a power law and a linear quadratic model, as well as to the special cases of a pure linear and a D^2 relation. If in a cell an exchange and several acentrics could be observed, either two fragments (assuming an incomplete exchange) or only one fragment (complete exchange) were assigned to the exchange. This results in two groups of acentric fragments ac_2 and ac_1 respectively. The dicentric, dicentric + centric ring, and different acentric data gave the best fit to the linear quadratic model $Y = c + \alpha D + \beta D^2$. The data for atypical translocation chromosomes are an exception and best fit a D^2 relation. With regard to the aspect of biological dosimetry a systematic investigation and interpretation of dose-effect relationships in human peripheral lymphocytes is given. Possible reasons for discrepancies between results of different laboratories, e.g., the varying statistical and mathematical treatment of experimental data, are discussed. This abstract, as prepared from the original language, appeared in volume 26 of NSA as abstract number 58985. (auth)

534 DOSE-RESPONSE CURVE FOR CHROMOSOME ABERRATIONS IN HUMAN LYMPHOCYTES IRRADIATED WITH 7.4 MeV PROTONS IN VITRO. Bocian, E.; Pszona, S.; Ziemba-Zak, B. (Inst. of Nuclear Research, Warsaw). Stud. Biophys.; 39: No. 3, 167-176(1973).

The whole human peripheral blood samples were irradiated with 50 to 400 rads of 7.4 MeV protons. The relationships were studied between the dose and yield of various types of chromosome aberrations. All data were fitted by least square regression analysis. The dicentric plus centric ring and the acentric fragment data gave the best fits to the quadratic equations: $y = -5.7 \cdot 10^{-5} + 5.1 \cdot 10^{-4} D + 5.3 \cdot 10^{-7} D^2$ and $y = 3.1 \cdot 10^{-3} + 1.0 \cdot 10^{-3} D + 1.4 \cdot 10^{-6} D^2$, respectively. Proton-irradiated lymphocytes contained also chromatid type aberrations. The frequency of chromatid aberrations was related to the proton dose according to the linear equation: $y = 1.4 \cdot 10^{-2} + 2.7 \cdot 10^{-4} D$. An exponential increase ($y = 1.71\ X^{0.54}$) was found of multi-aberration cells with dose in proton-irradiated lymphocytes. (auth)

535 EXTRACORPOREAL IRRADIATION OF THE BLOOD WITH THE TELECESIUM APPARATUS. I. Technical and Experimental Preparations. Makoski, H. B. (Univ., Essen); Huedepohl, G. Strahlentherapie; 146: No. 4, 414-421(Oct 1973). (In German).

The technical details of extracorporeal blood irradiation with a telecesium apparatus, in combination with special equipment, are described. Dosimetry is carried out by thermoluminescence with LiF-detectors. The equations for the dose calculations are developed. The methods described proved useful in practice. (GE)

536 RADIOBIOLOGICAL PROBLEMS ASSOCIATED WITH SUPERSONIC AEROPLANE FLIGHTS AND SPACE EXPLORATION. Delahaye, R. P. (Hopital d'Instruction des Armees Begin, Saint-Mande, France). Radioprotection; 8: No. 2, 119-137(1973). (In French).

Although the relations between irradiation dose and its effects are well known on earth, very scanty information is available for space flights, orbital flights, and high altitude supersonic flights. A great many uncertainties exist on the effects of galactic and solar cosmic radiation on man. (FR)

537 METABOLISM OF COMPOUNDS OF PLUTONIUM AND OTHER ACTINIDES. ICRP Publication 19. Oxford; Pergamon Press (1972). 55p. £1.50.

A task group of ICRP Committee 2 prepared a digest of the main bulk of the information available in open literature up to January 1971. It deals in some detail with: the chemistry of Pu and related elements, their biological behavior (hydrolysis, polymerisation, etc.); entry of Pu by inhalation (clearance, pathology, etc.); absorption of Pu and related elements (Am, Np, Th) from the gastrointestinal tract, through the intact skin; entry by injection, punctures, wounds; tissue distribution of absorbed nuclides; retention of deposited actinides (skeleton, bone marrow, liver, soft tissues) and depletion rates. (Occup. Saf. Health Abstr.)

538 BONE AND JOINT LESIONS FOLLOWING INTENSIVE RADIATION THERAPY. Chisleag, G.; Petrovanu, C. (Univ. of Iasi). pp 419-423 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (14 Sep 1971).

Changes in bone structure and joints among a group of 74 cancer diseased patients, treated by conventional roentgentherapy were studied. Conditions wherein lesions develop, the way they are roentgenologically expressed, and the possibility of treatment and prophylaxis were studied. Changes appeared in patients who received high doses (6000 R in a single course or 6-9000 R in repeated courses); they were manifest in 3 months to 5 years following irradiation. An important role in their production was attributed to vascular changes countenanced by the high resorption coefficient of the bone tissue and to the intense phenomena of ionization at its level. (auth)

539 CASE WITH EYE DISORDER DEVELOPED BY TELE-^{60}Co-RADIATIONS. Kogure, M.; Hashimoto, M.; Shirahama, Y.; Hirayama, A. (Tokyo Women's Medical Coll.). Ganka Rinsho Iho; 66: No. 12, 1144-1151(Dec 1972). (In Japanese).

Thirty-seven irradiations by use of a telecobalt unit in a total dose of 7500 rads in two months were given to a 33-year-old man after operation for squamous cell carcinoma of the right maxillary sinus. After the completion of irradiations, irradiation damages of ocular tissues were examined for two years and three months. Since the patient died from metastasis of carcinoma to the spinal cord, the eyes were extracted and examined histopathologically. During irradiations, conjunctivitis, erythema of the lids, and loss of the eyelashes and the eyebrows were observed. After irradiations, corneitis, formation of pseudomembrane of blepharoconjuctiva, retinopathy, iridocyclitis, infarction of Meibom gland, secretory dysfunction of lacrimal gland, optic atrophy, retinal atrophy, and cataract appeared in the order. Among them, erythema of the lids, conjunctivitis, and loss of the eyebrows were cured while other diseases were irreversible. Post radiation retinopathy characterizing this case appeared 11 months after the completion of irradiations. This is mainly an obstructive degeneration disease of reticular capillary vessels of the posterior polar region, showing hemorrhage, leukoma, microaneurysm of blood vessels, and telangiectasia of the retina, and causes ischemia of the retina. The continuation of this condition results in optic atrophy of the retina. The histopathological examination 2 years and 3 months after the completion of irradiations revealed an extensive atrophic degeneration covering the whole layers of the retina, hemorrhage from the range from the inner granule layers to the internal limiting membrane, and loss of a ganglionic layer. The wall of blood vessels became vitreous and the wall cells decreased. No abnormality was observed in the choroid. (JA)

540 TREATMENT OF THE SKIN CANCER. 2. Treatment With Electron Beams. Ishihara, K.; Yanagida, H. (National Cancer Center, Tokyo). Rinsho Hifuka; 27: No. 6, 537-543(Jun 1973). (In Japanese).

The basic concept of electron beam therapy is discussed with reference to the data of clinical treatments using the betatron (18 MeV) and the linear accelerator (6 MeV) for skin cancer in the National Cancer Center, Tokyo. Electron beams can be applied for treatment of cancer in such cases: when it is difficult to excise the lesion; when a patient is too old to have surgical operation; post-operational irradiation is considered necessary when the excision is incomplete; and preoperational irradiation is effective for successful excision of the lesion. Radiation dose should be controlled in regard to the kind of clinical cases: 3000 to 6000 R for basal cell cancer; 6000 to 8000 R for sickle cell cancer; and 8000 R for malignant melanoma. Pre-operational irradiation was effective for 15 cases out of 16 clinical cases with sickle cell cancer. Single irradiation with 3000 to 6000 R was effective for 40 cases out of 50 cases with sickle cell cancer, in which 4 patients died of cancer 3 years after irradiation. The combined treatment with bleomycin and electron beam proved effective for 3 cases. The combined treatment with bleomycin, excision, and irradiation was effective for 8 of 11 cases with skin cancer; the treatment elevated the survival rate although 6 patients died of cancer. The merits of electron beam treatment in comparison with x-ray treatment are: the energy level can be altered according to the size of the lesion; radiation injuries are considered less; and the permissible dose can be increased. (Japan)

541 STUDY OF THE KIDNEYS IN CANCER OF THE UTERINE CERVIX BEFORE AND AFTER RADIATION THERAPY. Petrosyan, A. O.; Makhmuryan, T. D.; Kazaryan, G. A. (Inst. of Roentgenology and Oncology, Erevan). Zh. Eksp. Klin. Med.; 12: No. 1, 80-82(1972). (In Russian).

Radioisotopic renography and scanning were carried out on the kidneys of 109 patients with cancer of the uterine cervix before therapy and of 75 of these after completion of a combined radiation therapy course. The results indicated that post-radiation changes occur in the kidneys immediately after the therapy is completed. The greatest change is in the filtration and excretory functions of the kidneys. (tr-auth)

542 DANGER: RADIATION, PLAY IT COOL. A Perspective on Nuclear Radiation Hazards. Cohen, B. L. (Univ. of Pittsburgh). Pub. Util. Fortn.; 93: No. 9, 55-57(25 Apr 1974).

543 ULCERATIVE RADIATION DERMATITIS. Auerbach, R.; Pearlstein, H. H. (New York Univ., NY). N. Y. State J. Med.; 73: 2183-2184(1 Sep 1973).

The treatment of patients with radiation dermatitis includes close clinical scrutiny and surveillance for the rest of their lives; whenever there is clinical evidence of tissue breakdown, surgical removal and histopathologic evaluation are necessary. Frank malignant growths are to be treated with surgical extirpation. In addition, these patients must be taught to avoid ultraviolet exposure and further ionizing radiation. (auth)

544 SKIN-SURFACE-EXPOSURE BY MAKING LONG-CONE AND SHORT-CONE EXPOSURES. Van De Poel, A. C. M.; Grootheddе, R. T. (Katholieke Univ., Nijmegen, Netherlands). Ned. Tijdschr. Tandheelk.; 80: 212-219(Jun 1973). (In Dutch).

A comparison was made of the surface-exposures in R/cm^2 at the entrance of the x ray beam in the skin as measured using the short-cone technique (f-o = 10 cm) and the long-cone technique (f-o = 45 cm). By the long-cone technique filmholders model Utrecht were also used; this type of filmholders possess an extra diaphragm. The lowest exposures were measured by using the long-cone technique with a lead lined open tube and filmholders with an extra diaphragm, and by using the Philips Oralix to change the plastic cone for a lead lined tube and by making bitewing radiographs from the premolar-molar region not to expose two dental films number 2 (3 × 4 cm) but one film number 3 (2.6 × 5 cm) with diaphragm 3. (auth)

545 POSSIBILITIES AND LIMITATIONS IN THE USE OF BIOLOGICAL INDICATORS OF RADIATION INJURIES. Skalka, M. (Chechoslovakia Academy of Sciences, Brno). Cas. Lek. Cesk.; 112: No. 31, 950-955(10 Aug 1973). (In Czech).

Biological indicators of radiation injuries are important for the determination of the degree of injury caused by acute irradiation due to a nuclear accident, in the course of therapeutic irradiation, and in chronic exposure to small doses. The biological and biochemical indicators do not fulfill all requirements desired. Most of the biochemical indicators trace products of breakdown of the cellular macromolecules of the radiosensitive tissues. These are, in the first place, metabolites of nucleic acids and proteins. Other tests trace functional changes of the organism and

individual organs and are less specific. It appears probable that no single, specific and universal indicators of radiation injury will be found. More is to be expected from complex evaluation of results of various selected indicators. From the point of biological detection of radiation injury new possibilities may be derived from both morphological [chromosomal aberrations] and biochemical study of the peripheral lymphocytes after their immunobiologic stimulation. (auth)

546 DOSIMETRY OF IONIZING RADIATIONS USED FOR THE TREATMENT OF CANCER OF THE CERVIX AND UTERUS. Raimondi, S. (Univ. of Obstetrics and Gynecology, Lausanne, Switzerland). Rev. Med. Suisse Romande; 92: 829-838(Oct 1972). (In French).

The use of a Hewlett-Packard 9100 A type small computer for dose calculations during ^{226}Ra implant therapy of cancer of the cervix and uterus is described. The radiation source is described and the principal anatomical references used are discussed. The dose measurements in the rectum made using thermoluminescent dosimeters are reported. (JSR)

547 MANAGEMENT OF TEETH IN THE IRRADIATED PATIENT. Marciani, R. D. (Univ. of Kentucky, Lexington); Plezia, R. A. J. Amer. Dent. Ass.; 88: No. 5, 1021-1024(May 1974).

Teeth in the direct line of radiation can be maintained in selected patients who are undergoing therapy for head and neck cancer. Careful clinical and radiographic evaluation is indicated. Alveolectomy and primary closure should be done before radiation therapy is begun if teeth are to be extracted. (auth)

548 TUMOR STERILIZATION WITH PREOPERATIVE RADIATION IN LARYNGEAL CANCER. Constable, W. C.; Fitz-Hugh, G. S.; El-Mahdi, A. M.; Marks, R. D. Jr.; Robbins, J. P. (Univ. of Virginia Hospital, Charlottesville). Arch. Otolaryngol.; 99: No. 4, 252-254(Apr 1974).

From 1st joint meeting of the Society of Head and Neck Surgeons and the American Society for Head and Neck Surgery; Hot Springs, VA (30 Apr 1973).

If there were a method of predicting which larynges have been cured by radiotherapy, unnecessary surgery and loss of function might be avoided. In a large series of patients with advanced cancer of the larynx treated by high-dose preoperative radiotherapy, the apparent sterilization of the primary tumor and metastatic lymph nodes was studied. The results are compared with results from other large series. The present study indicates that at least 40% of patients would avoid laryngectomy. Further, clinical response following radiotherapy gives an excellent indication of which patients would be cured by radiotherapy. The delay of surgery in those cases that developed recurrence did not result in a high complication rate. This policy—radiotherapy with surgery for salvage of recurrences—has achieved a control rate comparable to that achieved by high-dose preoperative radiotherapy and surgery. (auth)

549 DOSE ESTIMATION OF HUMAN FETUS EXPOSED IN UTERO TO RADIATIONS FROM ATOMIC BOMBS IN HIROSHIMA AND NAGASAKI. Hashizume, T.; Maruyama, T.; Nishizawa, K.; Nishimura, A. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 14: No. 4, 346-362(Dec 1973).

The absorbed dose in the head of human fetus exposed in utero to gamma rays and neutrons from the 1945 atomic bombs in Hiroshima and Nagasaki was estimated as a function of distance from the hypocenter. The ratios of the absorbed dose in the fetal head to the in-air tissue absorbed dose was determined using a depth-dose curve and a dose build-up factor experimentally determined with simulated radiation sources of the atomic bombs. The ratio was corrected for the angular distribution of the atomic bomb radiations. The results showed that the ratios varied depending on a distance from the hypocenter, a posture of mother and her stage of pregnancy at the time of exposure, and ranged from the minimum value of 0.56 to the maximum value of 0.70 for initial gamma rays; 0.072 to 0.16 for recoil protons; 0.075 to 0.11 for gamma rays from $^{1}H(n,\gamma)^{2}D$ reaction; 0.0030 to 0.0082 for protons from $^{14}N(n,p)^{14}C$ reaction. The absorbed dose in the fetal head at the end of first month of gestation and at 1,000 m from the Hiroshima hypocenter was 194 rads for initial gamma rays; 22.2 rads for recoil protons; 15.8 rads for gamma rays from the $^{1}H(n,\gamma)^{2}D$ reaction, and 1.22 rads for proton from the $^{14}N(n,p)^{14}C$ reaction. (auth)

550 EXPOSURE DOSE IN ORTHOPANTOMOGRAPHY. Maekoshi, H.; Koga, S.; Nishizawa, K.; Kato, K. (Nagoya Univ., Japan). Rinsho Hoshasen; 18: No. 12, 960-964(Nov 1973). (In Japanese).

Exposure dose that the patients received using an orthopantomograph apparatus, a dental panoramic x-ray apparatus, was measured with a thermoluminescence dosimeter by using a phantom. In orthopantomography, skin dose of the head and neck was 300 to 500 mrads in ramus of the mandible, 60 to 130 mrads in occipital point, 6 mrads in the eyes, 2 to 6 mrads in the face, and 6 to 30 mrads in the neck. Dose of occlusal surface was 600 mrads in a section of ramus of the mandible, 150 to 300 mrads in the parotid gland, 30 mrads in anterior tongue at midline, 150 mrads in posterior tongue at midline, 100 to 150 mrads in the pharyngeal tonsil, 15 mrads in cross section of the neck where the thyroid gland exists, and 50 mrads in the spinal cord. Scattered rays were measured in the direction of the foot from the occlusal surface to know the gonad exposure dose. According to this, the amount of scattered rays in the air 50 cm below from occlusal surface was 0.35 mR per one photographing. Furthermore, these results were compared with the exposure dose by intraoral method and PANOREX method and were tabulated. In comparison of these exposure doses of right and left centers of rotation (the region of the parotid gland) showed high values by PANOREX and orthopantomography, but dose of the other main organs (the eyes, the thyroid gland, the spinal cord of the neck, the pharyngeal tonsil, etc.) showed the smallest values in orthopantomography. But, sufficient attention must be paid because environs of right and left centers of rotation recieve two or three times of exposure dose by simple photographing of the neck. (JA)

551 DOSIMETRY OF WORKERS AT THE IRI. Rasmussen, C. E. (Interuniversity Reactor Inst., Delft, Netherlands). pp B.9.1-B.9.3 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

The personnel at IRI are divided, for health physics purposes, into radiation workers, workers not performing radiation work but in radiation areas, workers not in above categories but whose annual dose equivalent cannot be limited to 0.5 rem, and other workers. The procedures, techniques, and instruments used for personnel dosimetry at IRI are discussed. (ERB)

552 SOME PROBLEMS OF INDIVIDUAL DOSIMETRY FOR THE EXTERNAL IRRADIATION OF THE PERSONNEL. Kniazev, V. A.; Pavlov, G. I. (State Committee for the Application of Atomic Energy, Moscow). pp B.12.1-B.12.10 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

Methods of individual dosimetry of external irradiation used at present give the possibility of controlling individual doses of chronic irradiation in accordance with the requirements of NRB-69. There is a practical necessity to determine scientifically the required precision of measurement of the individual doses of irradiation received by professional workers. (auth)

553 OCCUPATIONAL X-RAY EXPOSURE ASSOCIATED WITH INCREASED UPTAKE OF RUBIDIUM BY RED CELLS. Scott, K. G. Arch. Environ. Health; 26: No. 2, 64-66(Feb 1973).

The radionuclide ^{86}Rb was used to determine the uptake of erythrocytes in groups of workers occupationally exposed to x-radiation and in controls. In radiological employees who received x-ray exposure considered to be acceptable, the uptake of ^{86}Rb by the red blood cells was greater than in those receiving no measurable occupational exposure. Uptake was greatest at 2 or 3 times the natural background level, and it was greater in individuals having less than 10 years' occupational exposure. (Occup. Saf. Health Abstr.)

554 GRANULOSA CELL TUMOR. Ramamurthy, C. R. (General Hospital, Guntur, India). J. Obstet. Gynaecol. India; 22: No. 6, 711-714(1972).

Two cases, one in a 68 yr. old woman with hypertrophy of breasts, bulky uterus, and postmenopausal bleeding and another case of a broad ligament granulosa cell tumour in a young woman of 25 yr. after irradiation of ovaries for sterilization, are reported. A review of the literature of all clinicopathological effects of granulosa cell tumor is given. (25 ref.) (Indian Sci. Abstr.)

555 PHARYNGEAL CARCINOMA IN A SCAR AFTER SCLEROMA TREATED BY RADIOTHERAPY. Ostachowska-Majewska, K.; Skolyszewski, J. Otolaryngol. Pol.; 27: No. 1, 109-111(1973). (In Polish).

A 61-year-old patient developed pharyngeal cancer in a scar from x-ray treatment of scleroma 35 years earlier. The new lesion was successfully treated with ^{60}Co gamma radiation. (MG)

556 ERYTHROCYTE HAEMOLYSIS IN A HYPERTONIC PROPYLENE GLYCOL SOLUTION IN MINERS WORKING IN

DEEP URANIUM MINES. A Study of Dynamics. Nosek, J. Cas. Lek. Cesk.; 111: No. 39, 908-911(Sep 1972). (In Czech).

An in-vitro study of the extent to which the speed of erythrocyte haemolysis in a hypertonic propylene glycol solution may be employed as an indicator of radiation exposure is described. Haemolysis speed decreases with increasing exposure duration; however, the decrease becomes less pronounced after 5 to 10 years and tends to stabilize after this. The results obtained with this method are in agreement with those provided by other indicators: methaemoglobin-to-haemoglobin transformation speed; haemolysis speed in an alkaline buffer solution; variation of the concentration of polarographically active sulphydril compounds in the hydolysate, and variation of the stroma haemoglobin concentration. (Occup. Saf. Health Abstr.)

557 DISTRIBUTION OF SURFACE-INCIDENT X-RAY DOSES AT DIFFERENT MEDICAL EXAMINATIONS RECORDED BY LARGE SIZE FILM DOSIMETER. Bojtor, I.; Varterez, V.; Illes, A.; Koczkas, G.; Luzsa, G. (Orszagos Frederic Joliot-Curie Sugarbiologia es Sugaregeszsegugyi Kutato Intezet, Budapest). pp 321-325 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Exposure to the whole area of the body is not uniformly distributed during x-ray diagnostic examinations. This should be taken into account when calculating the integral dose. The surface isodose curves were calculated by computer on the basis of a large size film dosimeter worn by 400 and 25 patients, respectively, during chest- and gastric diagnostic x-ray examinations. The possibility of calculating the partial integral dose is pointed out. (auth)

558 TISSUE COMPENSATORS FOR MEGAVOLTAGE RADIOTHERAPY FABRICATED FROM HOLLOWED STYROFOAM FILLED WITH WAX. Boge, R. J.; Edland, R. W.; Matthes, D. C. (Gundersen Clinic, Ltd., La Crosse, WI). Radiology; 111: No. 1, 193-198(Apr 1974).

A method of tissue compensation for megavoltage radiation therapy is described. A small motor-driven routing tool is made to slide up and down along a bar which pivots from a fixed point simulating the radiation source. As the pointer moves over the patient's surface, the routing tool which is rigidly connected to it cuts a minified surface into a Styrofoam block which is in the position of the shadow tray. The hollowed Styrofoam is filled with wax and the compensator is completed. The wax mold with an appropriate compensating factor of 1.05 produces a uniform dose beneath the patient's surface. (auth)

559 VOLUME I. RADIATION PROTECTION GUIDES FOR LONG RANGE SPACE MISSIONS. VOLUME II. RADIOLOGICAL HEALTH ASPECTS OF FABRICATING OPERATIONS WITH THORIATED METALS. Earls, J. M. Ann Arbor, MI; Univ. of Michigan (1973). vp.

Thesis (Ph.D.).

Volume I: Manned space operations planned for the next decade or two will differ from those of the Apollo series in that larger numbers of personnel will be involved; mission times will be longer, which will increase the total accumulated radiation exposure from the natural background in space; and nuclear systems will be utilized both for propulsion and on-board power requirements. For the amounts of power required, radiation levels will be quite high. Presently accepted radiation protection guides for terrestrial occupational exposure are much too restrictive for future manned space operations. It is necessary to establish radiation protection guides for the next 10 to 20 years of manned space operations which will provide guidance for spacecraft design and mission-planning operations. This study establishes radiation-protection guides for future space missions, based on evaluation of data on effects of so-called conventional radiation exposures on animals and man. Volume II: Thoriated tungsten electrodes are exempted from regulations of the U. S. Atomic Energy Commission (A.E.C.) but other thoriated metals are not. The electrodes normally contain 1 to 2 percent thoria (ThO_2). Within the group of industries which utilize thoriated metals other than welding rods, a serious question has arisen concerning the alleged hazard associated with the use of these metals in fabricating operations. (Diss. Abstr. Int., B)

560 RESEARCH NEEDS FOR ESTIMATING THE BIOLOGICAL HAZARDS OF LOW DOSES OF IONIZING RADIATIONS. Washington, DC; National Academy of Sciences (1974). 62p.

The findings and recommendations of the NAS–NRC Ad Hoc Panel on Research Needs for Estimating Biological Hazards of Low Doses of Ionizing Radiation are presented. The panel was formed in 1973 in response to a request from the USAEC for an evaluation of the current status of knowledge and research pertaining to the biological effects of low-level ionizing radiations. Emphasis was placed on those effects considered to pose a significant risk to human health at the low radiation dose rates approaching natural background levels, including genetic effects and those somatic effects relevant to the induction of cancer. The panel recommended that: no new large-scale, low-dose or low-dose rate mammalian studies be undertaken in an attempt to narrow the confidence limits associated with present estimates of induced human mutation rates; that experiments be undertaken to determine whether the human immature oocyte responds to radiation in the same manner as does the mouse oocyte; that the induced nondisjunction rate in mice be determined accurately; that the relation between cancer incidence and radiation dose be studied judiciously in selected human populations; that the mechanisms of carcinogenesis and radiation dose-incidence relationships be studied in experimental animals; that the influence of radiation dose, dose fractionation, and LET in carcinogenesis be studied in animals; that greater precision be sought by the continued development of in vivo and in vitro genetic test systems to provide data for comparisons between other species and humans; that the mechanisms of carcinogenesis induction by ionizing radiations be studied at the cellular and molecular levels in both in vivo and in vitro systems; and that model systems be used for studies of low radiation dose and dose rate studies. (CH)

561 MORTALITY IN THE CHILDREN OF ATOMIC BOMB SURVIVORS AND CONTROLS. Neel, J. V. (Univ. of Michigan, Ann Arbor); Kato, H.; Schull, W. J. Genetics; 76: No. 2, 311-326 (Feb 1974).

A continuing study of mortality rates among children born to survivors of the atomic bombings and a suitable group of controls has been updated; the average interval between birth and verification of death or survival is 17 years. The mortality experience is now based on 18,946 children liveborn to parents one or both of whom were proximally exposed, receiving jointly an estimated dose of 117 rem; 16,516 children born to distally exposed parents receiving essentially no radiation; and 17,263 children born to parents not in Hiroshima or Nagasaki at the time of the bombings. No clearly significant effect of parental exposure on child's survival can be demonstrated either by a contingency χ^2 type of analysis or regression analysis. On the basis of the regression data, the minimal gametic doubling dose of radiation of this type for mutations resulting in death during (on the average) the first 17 years of life among liveborn infants conceived 0 to 13 years after parental exposure is estimated at 46 rem for fathers and 125 rem for mothers. On the basis of experimental data, the gametic doubling dose for chronic, low-level radiation would be expected to be three to four times this value for males and as much as 1000 rem for females. (auth)

562 CLINICAL EXPERIENCE OF PATIENTS WITH CARCINOMA OF THE LUNG AND CHRONIC PULMONARY DISEASE TREATED BY RADIOTHERAPY. Green, N.; Iba, G.; Shirey, J. K. (Hospital of the Good Samaritan, Los Angeles, CA). Radiology; 111: No. 1, 189-192(Apr 1974).

Of 41 patients with lung cancer and chronic pulmonary disease who underwent radiotherapy, 31 had tumor regression and 20 had subjective improvement. Radiation-induced complications developed in nine cases. Patients with chronic pulmonary disease and lung cancer usually had an early death. The pulmonary disease may have had an adverse effect on survival, negating the benefit of radiotherapy. Patients who had hemoptysis, chest pain or superior vena cava syndrome benefitted from radiotherapy. The median survival was five months. Radiotherapy was of no value for patients with a peripheral tumor location or for patients who did not have symptoms caused by lung cancer. (auth)

563 LONGEVITY IN RADIATED HUMAN POPULATIONS, WITH PARTICULAR REFERENCE TO ATOMIC BOMB SURVIVORS. Anderson, R. E. (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Amer. J. Med.; 55: 643-656(Nov 1973).

Life shortening is one of the late consequences of exposure of a variety of laboratory animals to biologically significant amounts of ionizing radiation. Evaluation of several human populations accidentally and/or therapeutically exposed to radiation suggests a similar phenomenon among the radium dial painters and pioneer American radiologists which persists even when appropriate corrections are made for the known tumorigenic effects of such exposure. A similar relationship is at most equivocally reflected in the experience to date pertinent to the survivors of the atomic bombs of Hiroshima and Nagasaki. Reviewed here are the available data in this regard, with particular reference to the information relevant to the atomic bomb survivors. (auth)

564 SERUM IMMUNOGLOBULIN LEVELS IN ATOMIC BOMB SURVIVORS IN HIROSHIMA, JAPAN. Hall, C. B. (Univ.

of Rochester School of Medicine, NY); Hall, W. J.; Ashley, F. W.; Hamilton, H. B. Amer. J. Epidemiol.; 98: No. 6, 423-429(1973).

Serum immunoglobulins were evaluated on 803 atomic bomb survivors and matched controls with respect to their past exposure to ionizing radiation and past medical record of 15 to 22 years. Mean serum IgG and IgA levels were higher than those reported for Americans. Age and sex influenced immunoglobulin levels. With advancing age, IgG and IgA increased in males, and IgM decreased in females. Among clinical abnormalities associated with altered patterns, elevated sedimentation rates and increased lymphocytes were accompanied by significantly increased immunoglobulin levels. Levels were higher in the presence of radiologic evidence of tuberculosis. Mean IgG levels were higher in those exposed to radiation compared to controls. This was statistically significant only for females. (auth)

Vertebrates

Refer also to abstracts 470, 670, and 1758.

565 (AD-764885-0) INCREASED BRAIN RADIORESISTANCE AFTER SUPRALETHAL IRRADIATION. Chaput, R. L.; Berardo, P. A.; Barron, E. L. (Armed Forces Radiobiology Research Inst., Bethesda, Md. (USA)). May 1973. 28p. (AFRRI-SR-73-7) NTIS $3.00.

Clinical symptoms and performance were evaluated after shuttlebox-trained miniature pigs received two 4400-rad doses separated by time intervals of .0001 to 30 minutes. The doses were delivered to the head by 45-MeV electrons from the AFRRI electron linear accelerator (LINAC). There was no significant difference in neurological symptoms (convulsions, coma, ataxia) or in performance after the second dose between animals that received the two doses .0001 or 0.3 minute apart. As the time interval between doses was increased from 0.3 to 3 minutes, however, neurological symptoms declined and performance improved markedly after the second dose. When the doses were 30 minutes apart, the pigs showed no decrease in performance within the initial 30 minutes postirradiation. It was concluded that more than physicochemical processes were involved in the increased radioresistance to the second dose of radiation. (auth)

566 (AD-764971-8) RELATIVE EFFECTIVENESS OF FISSION NEUTRONS FOR GASTROINTESTINAL DAMAGE IN MICE: JEJUNAL CRYPT STEM CELL SURVIVAL. Zeman, G. H.; Jones, S. R.; George, R. E.; Levin, S. G. (Armed Forces Radiobiology Research Inst., Bethesda, Md. (USA)). Feb 1973. 15p. (AFRRI-SR-73-3). NTIS $2.75.

Mice were unilaterally irradiated in either a fission neutron or gamma ray field at various dose rates. Jejunal crypt stem cell survival was analyzed by the multitarget single-hit survival model, which yielded excellent fitting survival curves. At the 1 percent survival level, gamma rays were 20 percent more effective in destroying cells when delivered in a brief pulse of radiation than when delivered at lower dose rates (40 rads/minute or 250 rads/minute). Increased cell survival was not observed for low dose rate neutrons. Dose values obtained were consistent with the findings of similar studies; however, survival curve intercepts were found to be lower than previous estimates. (auth)

567 (AD-767583-8-GA) COMPARISON OF THE 60-DAY MORTALITY RESPONSES OF LAMBS AND ADULT SHEEP AFTER UNILATERAL EXPOSURE TO COBALT-60 GAMMA RADIATION. Technical Report, 30 June 1969–17 April 1970. Spangler, S. G.; Olson, C. T. (Air Force Weapons Lab., Kirtland AFB, N. Mex. (USA)). Sep 1973. 30p. (AFWL-TR-73-126). NTIS $3.00.

Fifty-three lambs and 24 adult sheep were exposed unilaterally (right side) to potentially lethal doses of cobalt-60 gamma radiation (200 to 500 R, midline air dose). The incidence of mortality during the first 60 days post-exposure was recorded and analyzed. The median lethal dose (LD-50) for the lambs was 347 R, and the slope of the probit regression line was 22.24 probits per decade increase in dose. For the adults, the LD-50 was 381 R, and the slope was 4.25 probits per decade increase in dose. Compared to other sheep mortality data, the slope of adult line was unusually small; and it is questionable as to whether or not it is a close approximation to that of the entire population. The average day of death for those lambs which died within the first 60 days post-exposure was 21.3 days. Both the average and standard deviation were significantly smaller than those reported elsewhere for bilaterally exposed adults. On the basis of the available data, it appears that the difference in averages can be attributed to the youth of the lambs rather than to the exposure aspect. (GRA)

568 (AD-767633-1-GA) DELAYED MATCH-TO-SAMPLE PERFORMANCE DECREMENT IN MONKEYS FOLLOWING COBALT-60 IRRADIATION. Bruner, A.; Bogo, V.; Jones, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. (USA)). 10 Aug 1973. 48p. (DNA-3159-T). NTIS $3.00.

Findings are presented on the behavioral effects of cobalt-60 gamma irradiation on monkeys performing a complex delayed match-to-sample (DMTS) task or a simpler visual memorization task. It was found that the DMTS group reflected clear performance decrement at lower doses (e.g., several hundred rads midbody) than previously reported, while the memorization animals tended to show either no decrement or, in a few cases, response cessation (i.e., early transient incapacitation). The latter result has been characteristic of simple visual discrimination tasks when radiation doses of approximately 1000 rads have been employed. The differences between the two present groups, and the contrasts drawn with previous studies, were explained as a function of greater complexity of the DMTS task and an improved scoring procedure for performance decrement. (GRA)

569 (COO-3017-13) RADIATION CARCINOGENESIS. Progress Report I, 1 May 1972–15 March 1974. Warren, S.; Gates, O. (New England Deaconess Hospital, Boston, Mass. (USA). Cancer Research Inst.). 1974. Contract AT(11-1)-3017. 22p. Dep. NTIS $4.25.

In parabiont rats, one irradiated, one shielded, tumors appeared earlier in both, increased in number also in the irradiated. A distinctive tumor is the anastomotic sarcoma. Leukemia when present may involve only one of the pair. An induced transplantable pheochromocytoma serves as a model of the disease in man. Electron microscopic studies showed it to secrete both epinephrine and norepinephrine. Renal tumors, 0.5% in controls, increased to 10% in irradiated parabiont partners. To increase their incidence by stress, unilateral nephrectomy was done, disturbing FSH levels; half the irradiated female partners developed mammary cancer. A radiation-induced cancer of the breast was studied in a woman fluoroscoped in youth. Radiation studies in mice added specific evidence of aging as another accessory factor in tumorigenesis. Tumors induced were studied in relation to these multiple factors and effect of radiation injury per se on target tissues. A radiation-induced mutation in RAP mice caused abnormal calcium metabolism and rare tumors. The $LD_{30/30}$ in NEDH rats ranged from 710 to 905 R, currently 820 R. In pathogen-free animals most deaths were hematopoietic. Lifespan studies show parabiosis to add over 500 days to survival of lethally-irradiated rats. (auth)

570 (LF-46, pp 173-179) EFFECT OF PARTIAL ^{60}Co THORACIC IRRADIATION UPON PULMONARY COLLAGEN METABOLISM AND FRACTIONATION IN SYRIAN HAMSTERS. Pickrell, J. A.; Harris, D. V.; Hahn, F. F.; Belasich, J. J.; Jones, R. K. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Changes in pulmonary collagen metabolism resulting from radiation exposure were studied in Syrian hamsters. The animals received multiple thoracic doses of ^{60}Co γ radiation to achieve cumulative exposures of 6000, 4000, and 2000 R. Incorporation of the ^{14}C proline into pulmonary collagenous protein was elevated in the 6000 and 4000 R levels only at 13 to 14 weeks after initial exposure. At 21 to 22 weeks post-exposure, an increase in pulmonary tropocollagen content suggested an increased collagen synthesis. A variable increase in native collagen at 13 to 36 weeks suggested increased pulmonary scarring. A collection of alveolar macrophages at 7 to 8 weeks, followed by inflammation at 13 to 14 weeks and beginning pulmonary fibrosis at 13 to 19 weeks was noted. At 21 to 22 weeks post-exposure, a somewhat more marked pulmonary fibrosis, some epithelialization and at 35 to 36 weeks hemosiderin deposits were observed. These pathologic processes were lessened at 35 to 36 weeks after initial exposure. These results suggested that external γ irradiation increased the synthesis rate of collagen at an early time post-exposure. Later, collagen tended to accumulate and at 27 to 36 weeks, collagen synthesis had returned to normal rates and tissue pathologic changes were less pronounced. (auth)

571 (UCD-472-119, pp 2-4) EFFECT OF FRACTIONATED X-RAY EXPOSURES TOTALLING 100 R ON THE PRENATAL OVARY OF THE BEAGLE: A PRELIMINARY REPORT. Andersen, A. C. Jun 1972.

In annual report, fiscal year 1972.

The ovary in the dog is apparently quite radiosensitive to fractionated x ray exposures during the period of oögonial proliferation. Five dams receiving 10 R on alternate days (total 100 R) during the last trimester of pregnancy raised progeny whose ovaries showed demonstrable follicular damage, a comparable effect requiring a total of 200 R during the postnatal period when prophase meiosis occurs. (auth)

572 (UCD-472-119, pp 24-26) EFFECTS OF RADIOIODINE AND X-IRRADIATION ON BEAGLE PUPS. Book, S. A.; Bustad, L. K. Jun 1972.

In annual report, fiscal year 1972.

Doses of 1500 rads to the 4-mo-old Beagle thyroid from ^{131}I with or without 200 R whole-body x-irradiation or 4500 rads from ^{131}I decreased retention time of ^{131}I tracers in the thyroid, increased plasma cholesterol, and slightly reduced the levels of circulating thyroid hormones over the next 2 to 3.5 years. Peak ^{131}I uptake was decreased only in the 4500-rad group. Plasma proteins did not change appreciably, if at all. (auth)

573 (UCD-472-119, pp 34-43) 35-MeV PROTON IRRADIATION OF BEAGLE EYES. I. Clinical Observations. II. Histopathologic Observations. III. Lens Protein Alterations. Horn, P. L.; Shifrine, M.; Heffernon, U. Jun 1972.

In annual report, fiscal year 1972.

The eyes of Beagle pups were exposed to a 3-cm diameter beam of 35 MeV protons at 70, 125, 240, and 480 rad surface dose levels. Dose-dependent clinical responses were noted in the adnexa and crystalline lens. The most profound histopathologic changes were noted in the lens: epithelial hyperplasia and metaplasia, vacuole and plaque formation. The lenses from eyes receiving 240 and 480 rads had a higher percentage of insoluble protein than normal. Electrophoretic patterns of the soluble lens proteins from proton-irradiated eyes revealed two bands of intermediate mobility not seen in normal lenses. (auth)

574 (UCD-472-119, pp 44-49) EFFECTS OF CONTINUOUS ^{60}Co EXPOSURE ON WEANLING AND YOUNG ADULT BEAGLES: A PRELIMINARY PILOT STUDY. Momeni, M. H.; Chrisp, C. E.; Wilson, F. D.; Goldman, M.; Rosenblatt, L. S.; Waterman, D.; Shifrine, M.; Wolf, H. G. Jun 1972.

In annual report, fiscal year 1972.

Results are reported from studies on the effects of continuous low-level, whole-body ^{60}Co γ exposure on Beagles exposed at 7 weeks or 1.5 to 2 years of age. Parameters investigated in depth include quantitative and qualitative hematology, bone marrow cellularity and histopathology, cytogenetics, immunologic competence, changes in erythropoiesis, and ferrokinetics. (CH)

575 (UCD-472-119, pp 53-55) DNA POLYMERASE FROM CANINE TUMORS: PURIFICATION AND PROPERTIES IN COMPARISON WITH DNA POLYMERASES FROM VIRUSES AND VIRUS-INDUCED TUMORS. Huff, S.; Scibienski, E.; Galligan, S. J.; Taylor, N. J. Jun 1972.

In annual report, fiscal year 1972.

Results are reported from a study of the occurrence of RNA-directed DNA polymerases in radiation-induced tumors, spontaneous tumors, and transmitted tumors in the dog. The characteristics of DNA polymerases purified from cellular material were compared with those of viral reverse transcriptase to determine whether a viral agent may be involved in radiation-induced cancer in the dog. (auth)

576 (UCD-472-119, p 61) ELECTROPHORETIC ANALYSES OF BEAGLE SERUM PROTEINS. Shifrine, M.; Heffernon, U. Jun 1972.

In annual report, fiscal year 1972.

Data are presented on serum protein values from electropherograms of Beagles 1 to 60 days of age. (auth)

577 (UCD-472-119, pp 62-63) TRACE ELEMENTS IN SERUM. Fisher, G.; Rosenblatt, L. S.; Goldman, M. Jun 1972.

In annual report, fiscal year 1972.

Serum iron and serum copper levels of control and irradiated beagles were analyzed. A significant radiation-related effect was found in the serum iron levels. Markedly elevated copper levels were observed in 5 male irradiated dogs. (auth)

578 SPLENECTOMY AND RADIATION SENSITIVITY. O'Grady, L. F.; Lewis, J. P. (Univ. of California, Davis). Exp. Hematol.; 1: 215-221(1973).

Mice were splenectomized or underwent sham splenectomy. Six weeks later they were randomized into three groups: Group 1 received an $LD_{50/30}$ of whole-body irradiation; Group 2 received an $LD_{100/30}$ of irradiation plus an infusion of 25,000 syngeneic marrow cells, a cell dose permitting survival of 50% of the animals; and Group 3 received a dose of cyclophosphamide lethal to 50% of the animals. Those animals in Groups 1 and 3 that survived did so by endogenous hematopoietic repopulation, analogous to patients receiving extensive radiation therapy or intensive chemotherapy. The survivors in Group 2 repopulated their hematopoietic tissue from the graft. Animals were observed for the length and frequency of survival. Compared to sham splenectomy, splenectomy did not influence the tolerance of animals to radiation or cyclophosphamide therapy. Thus, in contrast to other reports, these studies suggest that splenectomy does not enhance resistance to radiotherapy or chemotherapy. (auth)

579 COMPARATIVE STUDY OF THE ACTION OF IONIZING RADIATION AND RADIOMIMETICS ON THE THYMUS INVOLUTIVE AND RECOVERY PHASES OF YOUNG RATS. I. Effects of X Rays ($LD_{50/30}$). Gilbertini, G.; Catalini, N. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 53: No. 5, 486-491(Nov 1972). (In Italian).

The effect of a single irradiation of x rays on the thymus of young rats was studied. The thymic involution and recovery was investigated by checking weight, morphology, and histology. An early and severe histological damage was observed as well as the occurrence of a mitotic block within the first hours following irradiation. The mitotic activity was re-established shortly after. (auth)

580 RBE OF FISSION NEUTRONS, ^{60}Co GAMMA RAYS, AND 250 kV X RAYS FOR 28-DAY MORTALITY IN SYRIAN HAMSTERS. Corp, M. J.; Hulse, E. V.; Batchelor, A. L. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol.; 25: No. 1, 61-66(Jan 1974).

After irradiation with fission neutrons, x rays, or ^{60}Co gamma-rays, the $LD_{50/28}$ of Syrian hamsters was 307 rads, 870 R, and 1009 R, respectively. The earliest deaths, at six days, resulted from a mixture of intestinal damage and hemorrhage. The majority of deaths occurred either at 9 to 12 days or from 14 to 17 days. During this latter period infection in the mouth was common, often associated with the cheek pouches. The rbe for neutrons was 3.3 and 2.8 when compared with ^{60}Co gamma-rays and 250 kV X-rays, respectively. The rbe of x rays compared with ^{60}Co gamma-rays was 1.2. (auth)

581 INFLUENCE OF ALTERED IRON KINETICS IN THE MOUSE ON MEASUREMENT OF ERYTHROPOIESIS BY RADIO-IRON. Schofield, R. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Exp. Hematol.; 1: 376-380(1973).

The rate of clearance of ^{59}Fe from the plasma and the mean radioactivity per labeled red cell were measured at various times during repopulation of hemopoietic tissues following depletion by irradiation. There appears to be a fairly close relationship between the two parameters. On the other hand, changes in plasma iron do not appear to have any obvious influence. (auth)

582 DIFFERENTIAL RELEASE OF LATENT LYSOSOMAL HYDROLASES IN MUSCLE OF TILAPIA MOSSAMBICA BY WHOLE-BODY GAMMA RADIATION. Warrier, S. B. K.; Ninjoor, V.; Sawant, P. L.; Hirlekar, M. G.; Kumta, U. S. (Bhabha Atomic Research Center, Trombay, India). Indian J. Biochem. Biophys.; 9: No. 3, 278-279(1972).

The skeletal muscle lysosomal enzymes of fresh water fish Tilapia mossambica were found to exhibit structural latency to the extent of 35 to 50%. Whole-body γ irradiation of fish induced different release of aryl sulphatase, cathepsin, B-glucuronidase, acid phosphatase, and acid ribonuclease from muscle homogenate. (Indian Sci. Abstr.)

583 ASPECTS OF OVARIAN RADIOSENSITIVITY. Vatistas, S.; Lindop, P. J. (St. Bartholomew's Hospital, London). pp 409-412 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (Ed.). Vienna; Wiener Medizinische Akademie (1971).

From 1st European biophysics congress; Baden, Austria (Sep 14, 1971).

The ovarian response to low doses of whole-body irradiation was quantitated by the numerical depletion of the oocytes, and a disproportionately smaller impairment of reproductive life-span in the SAS/4 female mice. This reduced functional impairment might be explained by taking into account the following: That the oocyte population is in progressive equilibrium between the three main existing compartments toward follicular maturity. The mature compartment "C" is maintained at a steady level during the reproductive life of the mouse and may directly correspond to the number of mice per litter. Such a compensation is feasible in the presence of an excess of immature oocytes undergoing spontaneous atresia. If this spontaneous atresia is controlled by a feedback mechanism then the large cellular depletion at an early age due to the high radiosensitivity of the immature oocyte could be "cushioned" by a readjustment of the spontaneous depletion rates. Thus, depending on the age at exposure there could be maintained an almost normal supply to compartment "C", with an insensitive endpoint of loss of reproductive capacity. (auth)

584 EFFECT OF THE WHOLE-BODY X-RAY IRRADIATION ON DNA OF THE SMALL INTESTINE AND LIVER IN ALBINO RATS. Vodop'yanova, L. G. Vestn. Leningrad. Univ., Ser. Biol.; 1: No. 3, 64-70(Jan 1973). (In Russian).

In tests on rats it was established that 72 hrs after whole-body x-irradiation at a dose of 1000 R the ratios adenine : thymine and purines : pyrimidines in the DNA are increased because of the decrease in the basic content of thymine. The change in the nucleotide composition does not cause a dislocation of the secondary structure of DNA or decrease of the molecular weight of DNA. (tr-auth)

585 EFFECTS ON MUSCLE SPINDLE DEVELOPMENT OF MULTIPLE AND SINGLE EXPOSURE TO X IRRADIATION. Maier, A.; Eldred, E.; Estavillo, J. A. (Univ. of California, Los Angeles). Int. J. Neurosci.; 5: 159-166(Apr 1973).

The effect on muscle spindle development of multiple exposure to x-irradiation was studied in the soleus and plantaris muscles of young rats. Growth in muscle volume and extrafusal fiber cross-sectional area was strongly reduced following exposures of 2400 to 4100 rad given within two weeks after birth. Spindles also demonstrated reduction in size of the nuclear bag and chain intrafusal fibers in the irradiated as compared to the contralateral muscle, but the difference was relatively less than that of the extrafusal fibers. The intracapsular space was reduced in some heavily irradiated spindles to the point where virtually no space was seen beneath the capsule wall. The number of clearly recognizable spindles was less in the heavily irradiated muscles. Essentially similar results were found in one rat given a single exposure to 4000 rad. The effects on the fibers are interpreted to indicate relative resistance to irradiation in development of the intrafusal musculature as compared to extrafusal fibers. (auth)

586 EFFECT OF ISOTOPES ON THE FROG MYOCARDIUM AND OF X IRRADIATION ON THE HYPERTROPHIC RAT MYOCARDIUM. Arsenescu, G.; Sabau, M.; Iazigian, A.; Ilca, M.; Bracz, L. (Medical and Pharmaceutical Inst., Tirgu-Mures, Romania). pp 397-401 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Effects of small doses of ^{32}P on the frog ventricular strips and the effects of x-irradiation on experimental LVH induced by aortic constriction have been studied in rats. The ^{32}P produced a significant increase of the Prp, a significant but transitory decrease of the Ac. Sometimes strong decreases of Prp and spontaneous ventricular rhythm appeared, which was depressed by anodal polarization. X-irradiation in rats produces a higher mortality than in the controls. Body weight decreases in both groups but more in the irradiated group. Hypertrophy develops also in surviving irradiated rats although to a smaller extent. DNA concentration was insignificantly modified but DNA content increased with heart weight in both groups. Mitotic index shows a significant increase in the number of the nuclei of interstitial cells, especially in the non-irradiated group. In standard ECG there is a left deviation of the electrical curve in both groups. The aortic construction is an antagonistic factor to x-irradiation which did not prevent the experimental ventricular hypertrophy but only diminished it. A true hypertrophy is associated with hyperplasia; one of the reasons for the DNA content increase with myocardial hypertophy is due to hyperplasia. (auth)

587 RADIOINDUCED LIFE-SHORTENING IN MICE AFTER LIFE-LONG CONTINUOUS IRRADIATION WITH VERY LOW DOSE RATES. Leuenberger, H. G. W. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). pp 385-389 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971). (In German).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Two groups of 900 mice (300 males, 600 females) were irradiated chronically with 0.2 R/d or 0.5 R/d of gamma rays (^{137}Cs) from the age of 75 days till they died. Compared with a control collective of 1000 animals, the irradiated groups showed a significant life shortening, which amounts to about 5% for the females at both dose rates, 9.1% for males at 0.2 R/d and 5.6% at 0.5 R/d. Moreover, radiation-induced changes in the average body weights and in the blood pictures were observed. These results confirm the suggestion, that no threshold value of the toxicity of ionizing radiation does exist. (auth)

588 EFFECT OF GAMMA-IRRADIATION ON THE Ca CONTENT OF STRIATED MUSCLES. Tigyi, J. (Medical Univ. of Pecs, Hungary). pp 403-407 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (Sep 14, 1971).

The changes of Ca content of striated muscles of the frog were studied after gamma irradiation of 700 rads. Muscles both isolated and in situ have shown a similar effect: immediately after irradiation there is a significant increase of the Ca content. As the ^{45}Ca experiment indicates the accelerated inward Ca flow would be reason of the phenomenon. During the post-irradiation period the character of the Ca movement in isolated muscles differs from that in in situ ones. There is a quick recovery period, with a compensatory overshoot effect in the in situ muscles. In isolated muscles this overshoot is missing, there is only a slow restitution of the original status. These experimental results are in a good correlation with earlier experiments about the changes of the excitability of irradiated muscles. Findings about the Ca-movement help the explanation of the changes of the excitability caused by irradiation. (auth)

589 CHANGES OF ELECTROLYTE CONCENTRATIONS IN THE RABBIT SERUM DURING IRRADIATION. Werner, E. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). pp 363-367 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

The continuous measurement of electrolytes in the rabbit serum without blood loss during irradiation by 30 MeV electrons (mean dose rate 700 rd/min) is described until death of the animal. Mean survival time was about 140 min according to an accumulated dose of 100 krd. Most striking changes were found in the potassium and bicarbonate concentrations. For a better interpretation of the results, blood pressure, pulse and respiration frequency were simultaneously recorded. Results can be interpreted on the basis of damage of cell membranes. (auth)

590 INHALED IRRADIATED TERPHENYLS: REACTION OF MURINE LUNG AND LIVER. Adamson, I. Y. R. Arch. Environ. Health; 26: No. 4, 192-196(Apr 1973).

Hydrogenated terphenyls are being used as reactor coolants at an experimental nuclear plant in Canada. The present paper presents and discusses the results of acute and chronic inhalation studies on mice exposed to an aerosol of irradiated terphenyl mixture. No evidence of pulmonary injury was revealed by light microscopy. Minor ultrastructural changes in the lungs and liver disappeared a few weeks after cessation of exposure to an aerosol concentration 5 times higher than the concentration present at the reactor site. (Occup. Saf. Health Abstr.)

591 EFFECTS OF X-IRRADIATION ON THE EARLY STAGES OF THE MEMORY SYSTEM IN RATS. Gould, M. N.; Yatvin, M. B. (Univ. of Wisconsin, Madison). Physiol. Behav.; 11: 177-179(1973).

Previously, it was demonstrated that late stages of the memory system are radioresistant. In the present study, early stage radiosensitivity was investigated in rats. The animals were given dark avoidance training by a one-trial method employing electric shock as the unconditioned stimulus. Then they were either exposed to 2000 R of whole-body x irradiation or sham irradiated. When the rats were tested 24 hr later, no difference could be detected between these groups. Based on the data from these experiments, the early stages of the memory system appear to be relatively radioresistant. (auth)

592 EFFECT OF VERY LOW DOSES OF IONIZING RADIATION ON THE PERMEABILITY OF CAPILLARIES. Alth, G.; Ogris, E. (Krankenhaus der Stadt, Vienna). pp 330-337 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971). (In German).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

The effect of very low doses of x rays on the permeability of capillary membranes of hyperemic skeletal muscles was studied by simultaneous application of ^{133}Xe and ^{51}Cr EDTA as tracer molecules. It is thus possible to study the capillary blood flow as well as the increase in the permeability of the capillary wall. (auth)

593 PRODUCTION OF HIGH PLASMA LEVELS OF ERYTHROPOIETIN IN MICE. Tambourin, P. E.; Wendling, F.; Gallien-Lartigue, O.; Husulme, D. (Institut du Radium, Orsay, France). Biomedicine; 19: 112-116(20 Mar 1973).

A convenient method for preparing high plasma levels of erythropoietin in isogenic mice is described. An average yield of approximately 40 units/ml of plasma is currently obtained with mice made anemic by x-ray irradiation (600 rads) and phenylhydrazine treatment (60 mg/kg body weight). Bioassays in vivo and in vitro of the anemic plasma gave about the same results regarding the potency. (auth)

594 EFFECT OF IONIZING RADIATION ON THE ENDURANCE OF ACHILLES TENDON SCAR IN RABBITS. Dobrowolski,

Z.; Buczek, A.; Homik, J. Pol. Przegl. Chir.; 45: No. 9, 1197-1201(Sep 1973). (In Polish).

The endurance of Achilles tendon scars in rabbits subjected to the action of ionizing radiation in doses producing clinical manifestation of radiation sickness was investigated. The obtained results suggest that the endurance of Achilles tendon scar to elongation and tearing is correlated with the size of the dose of x rays to the whole body. (auth)

595 EFFECT OF A THYMIC HUMORAL FACTOR ON DIFFERENTIATION OF THYMUS-DERIVED LYMPHOCYTES. Lonai, P.; Mogilner, B.; Rotter, V.; Trainin, N. (Weizmann Inst. of Science, Rehovoth, Israel). Eur. J. Immunol.; 3: 21-26(1973).

The effect of a thymic humoral factor (THF) on the differentiation of thymus-derived (T) lymphocytes was studied in various graft-versus-host models. It was demonstrated that THF, which is known to be capable of restoring immunocompetence of cells from neonatally thymectomized mice, does not act on lymphoid populations devoid of T cells. Immunologically defective lymphoid cells such as spleen cells obtained from mice treated with anti-lymphocyte serum could be activated by THF by in vivo or in vitro interaction. These experiments indicate that the target cell acted on by THF is a T cell with a low level of immunocompetence. It is suggested that THF acts on young T cells and transforms them into mature T cells active in cell-mediated immune reactions, presumably without substantial multiplication. (auth)

596 CHANGES IN THE LYMPHOID TISSUE OF THE THYMUS AND THE LYMPH NODE IN ADRENALECTOMIZED RATS AFTER INCORPORATION OF ^{137}Cs. Khussar, Yu. P.; Tokin, I. B. (Tartu State Univ., Leningrad). Biol. Nauki; No. 3, 64-69 (Mar 1973). (In Russian).

Internal irradiation of adrenalectomized rats with ^{137}Cs resulted in considerable destructive changes in the lymphoid tissue of the thymus and lymph nodes and caused decreased mitotic division in the lymph cells. Recovery began 7 days after irradiation. (tr-auth)

597 GLYCOGEN, LACTIC ACID, AND PYRUVIC ACID CONTENTS OF RAT MYOCARDIUM IN ACUTE RADIATION SICKNESS. Movsesyan, M. A.; Barkhudaryan, L. Kh.; Arutyunan, D. E. (Armenian Inst. of Roentgenology and Oncology, Erevan). Zh. Eksp. Klin. Med.; 12: No. 1, 23-26(1972). (In Russian).

The effects of exposure to doses of 500 or 1000 R x radiation on the content of glycogen, lactic acid, and pyruvic acid in the myocardium of rats were studied. The glycogen content increased in relation to the radiation dose. (tr-auth)

598 EFFECT OF WHOLE-BODY X-IRRADIATION ON ANTIBACTERIAL AND ANTIGEN-DEGRADING SYSTEMS OF THE SERUM AND OF PHAGOCYTIC CELLS. Stefanovic, J.; Absolonova, O.; Kotulova, D. (Komenskeho Univ., Bratislava). Folia Fac. Med. Univ. Comenianae Bratislav.; 10: No. 1, 7-55(1972). (In Slovak).

Changes in the cellular and serum indicators of immunologic reactivity were studied in whole-body x-irradiated rabbits. Investigated were the bactericidal activity of rabbit phagocytes, the proteolytic activity of polymorphonuclear leukocytes, spleen cells, and peritoneal and alveolar macrophages, the number of leukocytes in the blood, the trypsin-inhibitor activity of the serum, and the level of the serum lysozyme. The changes were ascertained to be dependent on the dose and the time interval in which they were studied. Out of three different doses, viz., 150 R, 500 R, and 1,000 R, with a dose of 500 R a characteristic change was found: the most intensive changes were observed for between the 6th and 10th days after exposure; the return back to normal was observed after the 21st day following exposure. (auth)

599 REACTIVITY OF IRRADIATED ORGANISM TO ANALGESICS. Kovalcik, V.; Zabojnikova, M. (Komenskeho Univ., Bratislava). Folia Fac. Med. Univ. Comenianae Bratislav.; 10: No. 2, 183-229(1972). (In Czech).

The efficiency of analgesics, both narcotic and non-narcotic, was studied in whole-body x-irradiated mice and rats to find whether or not the reactivity of the organism to analgesics changes as a result of irradiation. Investigated were morphine, pethidine, and methadone as typical narcotics, and aminopyrine as a typical non-narcotic analgesic. In various tests carried out at various intervals following radiation exposure, the assumption was confirmed that irradiation does not significantly affect the efficiency of the analgesics studied, as the reactivity changes of the irradiated organisms were not statistically significant. (auth)

600 SENSITIVITY OF DENTINOGENESIS IN THE RAT INCISOR TO ROENTGEN RAYS AND TO CYCLOPHOSPHAMIDE. Koppang, H. S. Oslo; Universitaetsforlaget (1973). 172p.

Thesis.

The radiosensitivity of dentin in the rat incisor to x radiation was studied and the injuries compared with those induced by cyclophosphamide. The effect of the radioprotective substance cystamine was also investigated. It was found that doses of 200 R were capable of inducing lesions in superior incisors, while a dose of 700 R was necessary to induce lesions in inferior incisors. Administration of cystamine prior to irradiation seemed to produce a radiosensitizing effect at doses below 450 R in superior incisors, and 575 R in inferior incisors, and a protective effect at higher doses. A positive relationship between lesion size and dose was observed. New light is shed on the nature of osteodentin in the x ray induced lesion. The findings support the concept of a greater sensitivity of superior compared with inferior incisors. (NO)

601 EFFICACY OF CHEMICAL PROTECTION AGAINST RADIATION SHORTLY AFTER EXPOSURE IN RELATION TO STATES OF THE MITOTIC CYCLE. Vsevolodov, E. B.; Litvinova, L. D.; Vishnevskaya, S. S. (Inst. of Experimental Biology, Alma-Ata, USSR). Izv. Akad. Nauk Kaz. SSR, Ser. Biol.; No. 3, 84-90(1973). (In Russian).

Rats were administered aminoethyl thiouranium (AET) 10 min before irradiation at 50 or 100 R and sacrificed 3 and 6 hrs later to obtain smears of bone marrow suspensions for histoautographic examination. Cells irradiated in the S phase were better protected against interkinetic death than the other cells and better protected against chromosomal aberrations than those irradiated in the G_2 phase. AET provided no protection against aberrations in cells irradiated in the G_2 phase. The number of anaphases and telophases with chromosomal aberrations among the dividing cells irradiated in the S phase decreased 6 hrs after a dose of 50 R by a factor of 1.7 and 3 and 6 hours after a dose of 100 R by a factor of 1.2 and 1.1, respectively. With an increase in the dose from 50 to 100 R and after the injection of AET, there was a change in the relative contribution of cells irradiated in various phases of the mitotic cycle, in the index of aberrations, in the mitotic index, and in the number of interphase degenerating cells. (JPRS)

602 LIPID METABOLISM IN THE ORGANS OF MICE IN RADIATION SICKNESS. Vinogradova, M. F. (Inst. of Radiology and Biology, Leningrad). Med. Radiol.; 18: No. 12, 59-61(Dec 1973). (In Russian).

Data on the degree of lipid restoration 8 hrs after irradiation of mice at doses of 800 R are reported. The study was made on tissue homogenates and on mitochordria of the intestines, liver, spleen, brain, muscles, and on blood. The results show that radiation injury causes substantial changes in the lipid metabolism in these organs of mice. (JSR)

603 SOME PROPERTIES OF THE CIRCULATING HEMOPOIETIC STEM CELLS. Gidali, J.; Feher, I.; Antal, S. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Blood; 43: No. 4, 573-580(Apr 1974).

Some properties of hemopoietic stem cells (CFU) circulating in the peripheral blood of the normal mouse (PCFU) were studied. Those parameters were chosen that are well-known characteristics of bone marrow stem cell populations. Leukocytes separated from the peripheral blood were the source of PCFU. The radiosensitivity (D_0 value), growth curve, seeding efficiency (f number), and the turnover state (number of PCFU in S phase measured by ^3H-thymidine killing technique in vitro) of PCFU were compared to the same parameters for bone marrow CFU. Several characteristic changes in these parameters were found for PCFU: lower radiosensitivity (D_0 = 140 R); higher seeding efficiency (f number 20.9%); and higher sensitivity to ^3H-thymidine in vitro (killing effect 32%). The doubling time was the same both for CFU and PCFU (21 hr), but the logarithmic growth of the PCFU population started by approximately 36 hr later than that of the marrow-derived CFU population. All these findings support the idea that PCFU represent a subpopulation of the heterogeneous bone marrow CFU population. (auth)

604 EFFECTIVENESS OF HYPERBARIC OXYGEN DURING FRACTIONATED IRRADIATION OF A TRANSPLANTED MOUSE TUMOR. Howes, A. E. (Univ. of Texas, Houston). Nat. Cancer Inst.; 52: No. 4, 839-842(Mar 1974).

A study was made of the response of C3H/He mouse mammary tumors to 10 equal fractions of ^{137}Cs γ rays given under air or high-pressure oxygen breathing (O_2, 30 psi) conditions; O_2, 30 psi also was given for the first or second half of treatment to determine the extent of the presence of hypoxic cells during each segment. Both latter forms of treatment produced tumor responses similar to those obtained when O_2, 30 psi, was given for all 10 treatments, which indicated the presence of large numbers of hypoxic cells at all stages of irradiation. By a cell survival model it was deduced that the extent of transfer of cells from a hypoxic to an oxygenated status was greater during the second

half of treatment than the first, under both air-breathing and O_2, 30 psi, breathing conditions. (auth)

605 RETENTION AND EXTINCTION OF RADIATION-INDUCED SACCHARIN AVERSION. Sessions, G. R. Athens, GA; Univ. of Georgia (1973). 103p. University Microfilms Order No. 73-31,961.

Thesis (Ph. D.).

Retention and extinction of radiation-induced saccharin aversion in rats were studied as adaptive specializations of ingestive behaviors. Groups of ten rats each were irradiated with 50 roentgens of whole-body x irradiation after drinking saccharin solution (0.1%). Irradiated groups and non-irradiated control groups were given 48-hr. two-bottle preference tests between 0.1% saccharin solution and tap water after delays of 1, 11, 21, or 31 days following irradiation. No further experience with saccharin was given during these delay periods. Additional preference tests were conducted on each group at various intervals to determine the effect of intermittent exposure to saccharin solution on extinction of the aversion. The results of the initial retention tests revealed no significant differences in saccharin preference scores between the groups tested after 1, 11, or 21 days delay. A decided aversion was observed in each of these groups. The group initially tested after 31 days delay, however, demonstrated a moderate preference for saccharin solution. This group did not differ significantly at the time of their initial preference test from the 1-day delay group that had gradually extinguished their aversion during continuous preference tests. Additional results suggested that one 48-hr. exposure to saccharin solution beginning 21 days following irradiation was sufficient to attenuate the extinction observed in the 31-day delay group. The results suggested that the conditioned aversion to saccharin solution underwent rapid decay after 21 days in those animals that had no exposure to saccharin until 31 days after irradiation. It was suggested that extinction of taste aversions must be explained as resulting from the interaction of decay and interference processes. Individual differences in extinction were noted as valuable sources of information concerning the extinction process. (Diss. Abstr. Int., B)

606 RADIOSENSITIVITY, TO TRANSLOCATION, OF PREMEIOTIC MALE GERM CELLS OF MICE OF DIFFERENT AGES. Ivanov, B.; Leonard, A. (CEN, Mol, Belgium). Mutat. Res.; 22: No. 1, 85-86(Jan 1974).

Male mice were exposed to 100 to 300 R of x rays immediately after birth or when 90 or 450 days old. One hundred days after exposure the mice were killed and meiotic preparations from the testes were made. Spermatocytes were examined for the presence of chromosome rearrangements induced in premeiotic germ cells. The chromosome anomalies in the irradiated mice were reciprocal translocations in the form of rings or chains. No significant difference was seen between the three age groups with respect to the number of abnormal cells and the complexity of chromosome rearrangements. (HLW)

607 REMOTE CYTOGENETIC EFFECT OF ACUTE IRRADIATION INJURY IN MONKEYS. II. Frequency of Chromosomal Anomalies in Lymphocytes of Peripheral Blood of Monkeys. Kosichenko, L. P.; Sazhchenko, L. A. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Genetika; 9: No. 12, 151-153(Dec 1973). (In Russian).

A great number of chromosome reconstructions occurred in cultured lymphocytes from peripheral blood of rhesus macaques, subjected to acute irradiation at doses of 450 to 650 R and examined 9 to 12.5 years after the irradiation injury. Symmetric chromosome exchanges constituted the main percentage of reconstructed chromosomes in the tissue studied. Asymmetric exchanges were not observed in the blood lymphocytes, entering the first mitosis in the conditions of cultured cells. The new clones of cells, marked by reconstructed chromosomes, were determined; some of them being of the same type both in blood lymphocytes and in bone marrow cells studied before. (auth)

608 SPERM-COUNT, EGG-FERTILIZATION AND DOMINANT LETHALITY AFTER X-IRRADIATION OF MICE. Searle, A. G.; Beechey, C. V. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 22: No. 1, 63-72(Jan 1974).

Adult male mice were given doses of 200 rad acute x-irradiation and mated at intervals to hybrid females over the next 9 weeks. Testis weights fell to 44% of normal during the 5th week and were still subnormal when observations ended in the 10th week. Epididymal-sperm counts fell in the 4th week (after a peak in the 3rd) and were very low in the 6th and 7th weeks, though still above zero. This reduction was followed by high frequencies of preimplantation loss in females mated to these males and dissected on the 12th day of gestation. Examination of eggs 1 to 2 days after ovulation showed that there was also a sharp decrease (from the normal level of almost 100%) in the fertilization index, no eggs being fertilized in some females while others showed an intermediate rate. It was concluded that much of the pre-implantation loss really stemmed from non-fertilization rather than from zygotic death. This possibility has already been envisaged by Bateman and others, and reinforces the belief that an index of dominant lethality based on post implantation death should be used whenever the mutagenic treatment is likely to induce much germ-cell killing. The data suggested that reduced fertilization is likely to occur in mice whenever sperm counts fall to less than 10% normal. (auth)

609 EFFECT OF AN ELECTROSTATIC FIELD ON THE SURVIVAL TIME OF WHITE NONPUREBRED MICE AFTER X IRRADIATION. Artsruni, G. G.; Romanov, G. V.; Kutuzov, A. D.; Peruzyan, L. A. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol.; No. 3, 435-438(1973). (In Russian).

Nonpurebred mice were subjected to whole-body irradiation at 500 R and then placed in a specially designed chamber where they were exposed to an electrostatic field of 1000 v/cm for 1 or 24 hours. More controls were alive 11 days after irradiation than experimental animals, but by day 30 the survival rate of the latter exposed to the electrostatic field for 1 and 24 hours was 27 and 36% higher, respectively. The higher initial mortality is attributed to the early biochemical changes triggered by the electrostatic field. Subsequent intensification of the oxidation-reduction processes prolonged the survival time of the more radioresistant animals. (JPRS)

610 RELATIONSHIP BETWEEN NUMBERS OF CHROMOSOME BREAKS PER MOUSE NUCLEUS AND EXPECTED NUMBERS OF TRANSLOCATIONS AFTER IRRADIATION. Papworth, D. G. Mutat. Res.; 22: No. 2, 168-174(Feb 1974).

Methods for deducing the mean number of translocations per cell as a function of the mean number of breaks per cell are discussed and mathematical equations are presented. The following topics are discussed: types of symmetrical exchange; number of rearrangements resulting in a single type s exchange; number of rearrangements resulting in a specified combination of symmetrical exchanges; and deduction of mean number of translocations per nucleus. (HLW)

611 INDUCTION OF TRANSLOCATIONS IN MOUSE SPERMATOZOA. I. Kinetics of Dose Response With Acute X-Irradiation. Searle, A. G. (Medical Research Council Radiobiology Unit, Harwell, Eng.); Ford, C. E.; Evans, E. P.; Beechey, C. V.; Burtenshaw, M. D.; Clegg, H. M. Mutat. Res.; 22: No. 2, 157-167(Feb 1974).

Adult male mice were given gonadal doses of 0-1200 rad acute x-irradiation and mated the same day. 531 sons, conceived within a week of the treatment, were tested for fertility and their testes examined cytologically for chromosome aberrations in spermatocytes. 55/57 of those diagnosed as semi-sterile and 35/40 of those diagnosed as sterile were judged to be heterozygous for one or more reciprocal translocations. Numbers of 0, 1, 2 . . . translocations per mouse showed a good fit to a Poisson distribution, in contrast to previous findings with spermatogonial irradiation. Although the dose response fitted a linear relationship, the power law equation of best fit had a dose-exponent of 1.41. Further analysis along similar lines to those used previously in Drosophila by CATCHESIDE, LEA AND HALDANE, which assumed random rejoining of breaks and direct proportionality between dosage and number of breaks, gave a close fit between the actual results and those expected if $\alpha q = 2.8 \cdot 10^{-3}$/rad, where α is the mean number of breaks per nucleus and q is the proportion which rejoin or restitute. By combining these data with those for litter-size reduction in F_1 (taken as a measure of induced dominant lethality) α was estimated to be 3.4×10^{-3} per rad. (auth)

612 CLINICAL AND PATHOLOGICAL OBSERVATIONS ON LETHALLY IRRADIATED MONKEYS TREATED WITH HUMAN BONE MARROW TRANSPLANT. Polese, M. M. E.; Rossi Torelli, M. (Centre Applicazioni Militari Energia Nucleare, S. Piero a Grando, Italy). Minerva Med.; 61: No. 77, 4171-4175 (1970). (In Italian).

Nine male monkeys (Cebus apella) weighing about 3500 g, were irradiated with 750 R of 220 Kvp on the whole body at the dose-rate of 50 R/min. Five irradiated animals were inoculated with 20 ml of a suspension of human bone marrow (3.2×10^6 cells/ml). While the four untreated monkeys died between the 11th and the 15th day with radiation syndrome, the treated animals died between the 4th and the 13th day. The histological study of the organs showed in the animals which survived longer, evidence of an attempt to regeneration of the erythropoietic and lymphatic systems. All the treated animals died suddenly and their general

conditions, up to the time of death, were asymptomatic and nearly normal. (INIS)

613 EFFECTS OF CEPHALIC RADIATION ON THE INCIDENCE OF SYSTEMIC TUMORS IN SWISS MICE. de Estable-Puig, R. F.; Estable-Puig, J. F. (Univ. Laval, Quebec). Arch. Fund. Roux-Ocefa; 6: 5-11(1972). (In Spanish).

As a late effect of low dose cephalic x-irradiation in Swiss mice with body shielded, systemic tumors were found. Controls of the same strain were negative. Although this pilot experiment suggests the existence of an indirect mechanism, further studies on this line are needed to evaluate the participation of a theoretically possible mechanism of altered hormonal balance or viral activation. (auth)

614 GENETIC RESISTANCE TO MARROW TRANSPLANTATION. Trentin, J. J.; Rauchwerger, J. M.; Gallagher, M. T. (Baylor Univ., Houston, TX). Biomedicine; 18: 86-88(Mar 1973).

A phenomenon of xenogeneic resistance to transplantation of rat bone marrow into lethally irradiated mice of only some strains is described. This phenomenon has numerous characteristics in common with the previously described phenomena of hybrid resistance and allogeneic resistance to marrow transplantation. Because of these common characteristics, the common designation of genetic resistance to marrow transplantation is proposed. Because of its unusual characteristics, genetic resistance to marrow transplantation is either non-immunological, or represents a previously undefined type of immune response. (auth)

Invertebrates

615 STUDY OF THE GENETIC PROCESSES IN THE IRRADIATED POPULATIONS. II. Effect of the Chronic X-Ray Treatment on the Concentration of Visible Mutations in the Laboratory Populations of Drosophila Melanogaster. Tomenko, T. V. (Inst. of General Genetics, Moscow). Genetika; 10: No. 1, 99-104(1974). (In Russian).

The fitness of different genotypes in the polymorphic model population of Drosophila Melanogaster and the effect of chronic irradiation on it were studied. The adaptive value of individuals having gene yellow was lower than that of wild individuals. For recessive genes: brown, eyeless, ebony stable equilibrium of gene frequencies was observed in all six model populations segregating for the mutative and its wild type alleles. Stable polymorphism is obviously connected with selective heterozygote superiority. The levels of stabilization of gene ebony in the V, VI irradiated populations were higher than that in control. (auth)

616 PROLIFERATION AND TRANSDETERMINATION OF DROSOPHILA MELANOGASTER IMAGO DISKS AFTER IRRADIATION WITH X RAYS. Simpson, P.; Ziller, C. (CNRS, Nogent-sur-Marne, France). Compt. Rend., Ser. D; 277: No. 17, 1765-1768(29 Oct 1973). (In French).

The irradiation of imago disks with x rays results in necrosis and subsequent differentiation defects. The transdetermination frequency is thus increased. (FR)

617 INDUCED STERILITY IN INSECTS. Curtis, C. F.; (Univ. of Bristol, Eng.). Advan. Reprod. Physiol.; 5: 119-165 (1971).

Studies on induced sterility in insects are reviewed under the following topics: general principles of the action of radiation and chemosterilants on insects; the cellular basis of sterility induced in spermatozoa and oocytes; dose-response relationships for dominant lethals induced in spermatozoa and oocytes; deaths caused by dominant lethals; dominant lethals and cell deaths in immature germ cells; partial sterility due to chromosome translocations; and applications. (HLW)

618 MATING BEHAVIOR AND COMPETITIVENESS OF GAMMA-IRRADIATED OLIVE FRUIT FLIES. Cavalloro, R.; Delrio, G. (EURATOM, Ispra, Italy). J. Econ. Entomol.; 67: No. 2, 253-255(Apr 1974).

The mating behavior and competitiveness of gamma-irradiated Dacus oleae (Gmelin) were studied. When pupae were irradiated 3 days before adult emergence with a dose of 8 krad, the resulting adult males mated a maximum of 24 times and inseminated females in the first 10 matings. Untreated males mated up to 28 times and transferred sperm at each copulation. At least ½ females remated. The mean interval between the 2 matings was progressively less when the 1st mating was to a normal male, a male irradiated in the adult stage, a male irradiated in the pupal stage, or an aspermic male. Irradiated males contribute competitive sperm and can reduce the fertility of a female previously mated to a normal male. In laboratory and field-cage experiments, a ratio of 8 sterile males : 1 normal male gave satisfactory reduction of egg hatch. (auth)

619 MODIFICATION OF RADIATION-INDUCED GENETIC DAMAGE IN DROSOPHILA MELANOGASTER MALE GERM CELLS WITH NUCLEIC ACID PRECURSORS. III. Effects on the Premeiotic Cells. Rajaraman, R.; Kamra, O. P. (Dalhousie Univ., Halifax, Nova Scotia). Mutat. Res.; 22: No. 1, 47-53(Jan 1974).

Using a 2-day brood pattern, the effect of 5-bromodeoxyuridine (BUdR) or 5-bromodeoxycytidine (BCdR) pre-treatment on the radiation-induced yield of sex-linked recessive lethals and translocations was studied in the spermatocytes and late gonial cells (DNA synthesis cells) of D. melanogaster. The DNA synthesis cells were irradiated (1.2 kR γ-radiation) in the pre-meiotic or post-meiotic stage. Irradiation of DNA synthesis cells in the pre-meiotic stage resulted in enhanced lethal frequency with BUdR (3.0%) and BCdR (2.9%) over the other pre-treatment conditions: saline (S), thymidine (TdR), and deoxycytidine (CdR) in the spermatocytes but not in the late gonial cells. The radiosensitizing property was evident with BCdR even when the DNA synthesis cells were irradiated in the post-meiotic stage, but not with BUdR pre-treatment. Probable reasons for contradicting results reported in the literature are discussed. (auth)

620 INFLUENCE OF THE WATER RADIOLYSIS PRODUCTS ON THE MORTALITY OF THE PROTOZOA SPIROSTROMUM AMBIGUUM. Balcerzak, C. (Medical Academy, Lodz, Poland). Ann. Acad. Med. Lodzensis; 12: 7-18(1971). (In Polish).

Which of the products of the water radiolysis cause the mortality of the protozoa Spirostomum ambiguum was investigated. The ionizing irradiation of a water molecule leads to the formation of free radicals OH and atoms H, which as a result of secondary reactions give molecular hydrogen and hydrogen peroxide. The molecular hydrogen—as it was shown—was not lethal to the protozoa. As for hydrogen peroxide, its concentration in the water irradiated with the lethal dose of 240,000 rads and containing the protozoa amounted to $(1.03 \pm 0.03)\ 10^{-4}$ (m/l). The same concentration of the hydrogen peroxide did not prove to be toxic to the nonirradiated protozoa, which perish only in the solutions of strength of over $2.5 \cdot 10^{-4}$ (m/l). The OH radicals were found to influence the mortality of the protozoa in a marked way: the increase in the radical OH concentration in the system involved an increased mortality of the protozoa, its decrease entailed a decreased mortality. No visible changes of the mortality of the irradiated animals could be observed as a result of the increased H concentration in the system. (auth)

621 STUDY OF THE GENETIC PROCESSES IN THE IRRADIATED POPULATIONS. I. Effect of Chronic X-Ray Treatment on the Size and the Concentration of Lethal and Semilethal Mutations of the Second Chromosomes in Laboratory Populations of Drosophila Melanogaster. Tomenko, T. V. (Inst. of General Genetics, Moscow). Genetika; 9: No. 12, 40-44(Dec 1973). (In Russian).

Six model populations of Drosophila melanogaster of homozygote line D-32 were investigated. Before irradiation the amounts and the concentrations of lethal mutations of all populations were established at the equilibrium levels (3000 individuals, 13%). After irradiation the size of the irradiated populations twice decreased and during 8 generations was lower than that of the control. To the tenth generation irradiated populations reached the level of the control and then their mean size was statistically larger than the control. Concentration of lethal and semi-lethal mutations in the control populations was established at the equilibrium level about 12% and in the irradiated populations increased; in ten generations the mutations were established at the equilibrium level about 26 to 27%. (auth)

622 EFFECTS OF PRIMARY AND SECONDARY RADIATION ON THE DEVELOPMENT AND LIFETIME OF DROSOPHILA MELANOGASTER. Giess, M. C.; Blanquet, Y.; Soleilhavoup, J. P.; Planel, H. (Univ., Toulouse). Compt. Rend. Soc. Biol.; 167: No. 3, 537-541(1973). (In French).

Space flights resulted in an activation of the larval and pupal development of Drosophila embryos. New experiments with better containers and improved dosimetry techniques were used to investigate the effects of primary and secondary cosmic radiation and to establish an accurate measurement of the correlation between the extent of the activation phenomena and the absorbed doses. (FR)

623 CYTOGENETIC ANALYSIS OF X-RAY INDUCED VISIBLE MUTATIONS AT THE YELLOW LOCUS OF DROSOPHILA MELANOGASTER. Roberts, P. A. (Univ., Leiden). Mutat. Res.; 22: No. 2, 139-144(Feb 1974).

In the course of a study to determine whether stable terminal deletions of the X chromosome can be recovered, a collection

of mutations of yellow, a gene near the tip of the X, was analyzed. Half of the yellow mutations induced by exposure of sperm and spermatids to 4000 R of x rays were associated with rearrangements detectable in polytene chromosomes. A number of exceptions to the rule that male viable, fertile and non-variegating mutants are unlikely to have grossly rearranged X chromosomes were found. The use of translocation and inversion breakpoints to localize genes may lead to errors unless caution is exercised because rearrangements independent of the specific locus are not uncommon. (auth)

624 EFFECT OF CAFFEINE ON REPAIR SYSTEMS IN OOCYTES OF DROSOPHILA MELANOGASTER. I. Mendelson, D. (Univ., Leiden). Mutat. Res.; 22: No. 2, 145-156(Feb 1974).

Young Drosophila females were treated with caffeine, then mated for 24 h to males that had been irradiated with 2000 R x-irradiation, so that only mature spermatozoa were sampled. The radiation-induced frequency of dominant lethals and sex chromosome loss in the paternal genome was determined. The results show that treatment of females with caffeine leads to an increase in the frequencies of radioinduced dominant lethals and to sex-chromosome loss. When young virgin females of the radioresistant stock $R5I_2$ were treated with caffeine and then irradiated with 3000 R x-irradiation, a striking increase in dominant lethals (in the maternal genome) was observed; caffeine treatment increased the x-ray response of the radioresistant stock to the level of the normal (+60) stock. It is suggested that caffeine reduces the efficiency of a system in Drosophila oocytes that repairs x-ray-produced chromosome breaks in both the paternal and maternal genomes. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 560, and 684–687.

625 (RISO-294) PROCEEDINGS OF THE THIRD INTERNATIONAL MEETING ON THE TOXICITY OF THOROTRAST, HELD AT THE FINSEN INSTITUTE, COPENHAGEN 25–27 APRIL 1973. Farber, M. (ed.). (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1973. 337p. (CONF-730475-).

From 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Separate abstracts were prepared for 26 papers presented at the conference. An additional five papers were presented on medical problems related to these studies. (HLW)

For abstracts of individual papers see: 626–640, 668, 669, 684–689, 716, 717, and 730.

626 (RISO-294, pp 104-113) CHROMOSOME ABERRATIONS CAUSED BY THOROTRAST. Kemmer, W.; Muth, H.; Tranekjer, F.; Borkenhagen, U. (Universitaet des Saarlandes, Homburg, Ger.). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

An attempt to find a dose-effect-relationship between radiation dose (^{224}Ra-equivalent) and chromosome aberration yield (dicentrics and accompanying fragments) was made. An increasing statistical correlation was found given by the straight line: $y = 6.6 + 0.16\ x$ (y = aberration yield, x = radiation dose). A computed curve for the values studied in the power function: $y = 4.4\ x^{0.22}$. Although the two relationships are statistically significant it may be impossible to establish a dose-effect-relationship between radiation dose and chromosome aberration rate in thorotrast patients, because the number of dicentrics scatters within large limits in different patients exposed to equal or similar doses. (auth)

627 (RISO-294, pp 114-125) EDINBURGH THOROTRAST SERIES: REPORT OF A CYTOGENETIC STUDY. Buckton, K. E.; Langlands, A. O. (Western General Hospital, Edinburgh). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Data derived from the study of cytogenetic damage in the peripheral blood lymphocytes of persons who had received intraarterial injections of 232-thorium dioxide in the past, are presented. Cytogenetic analysis of the peripheral blood of Thorotrast patients has not proved useful for dosimetry, but it is a useful guide to the level of biological damage present in the reticuloendothelial system. Where there is a high number of cells with stable rearrangements there would appear to be a high probability of finding a clone of cells with rearranged chromosomes. The clinical significance of these clones is unknown. (Denmark)

628 (RISO-294, pp 126-136) FOLLOWUP OF THOROTRAST PATIENTS FROM BOSTON, MASSACHUSETTS AND ANN ARBOR, MICHIGAN, USA. Janower, M. L. (St. Vincent Hospital, Worcester, MA). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Seven hundred and twenty-four patients who received Thorotrast for cerebral angiography and 315 control patients who underwent similar examinations were followed up to determine the incidence of radiation-related morbidity and mortality. Forty-two of the Thorotrast patients and 29 of the controls were subjected to extensive clinical and laboratory examinations. In the Thorotrast series, one case each of liver tumor, granulocytic leukemia, and non-alcoholic hepatic cirrhosis were found as well as two cases of localized thorotrastomas. The Thorotrast patients revealed evidence of early liver dysfunction by elevations in bromsulphalein retention and alkaline phosphatase tests. The most sensitive indicator of radiation exposure was the high frequency of chromosome aberrations. Anemia, elevated white counts, and abnormalities in red cell morphology were not found. (auth)

629 (RISO-294, pp 137-147) FOLLOW-UP OF DANISH THOROTRAST CASES. Faber, M. (Finsen Inst., Copenhagen). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

The temporary results of the follow-up of 1,005 Thorotrast injected patients are presented. Among the 756 patients who did not die from the neurosurgical disease 312 have died. Twenty-eight died from hepatic tumors of which 11 were the typical Thorotrast induced haemangioendotheliomas all with a latency period of more than 15 years. A further 11 died from leukemia with a latency period of as little as 7 to 8 years. The expected rate of death from all these tumors is less than 5. The follow-up continues. (auth)

630 (RISO-294, pp 157-162) ACTUAL STATUS OF THE GERMAN THOROTRAST STUDY. van Kaick, G.; Scheer, K. E. (German Cancer Research Center, Heidelberg). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

The German Thorotrast study is a supra-regional compound research program, containing clinical and biophysical examinations of Thorotrast patients and a control group. The causes of death were ascertained for those thorotrast patients who died later than 3 years after the injection of Thorotrast or 3 years after their hospitalization. A follow-up-study was started in 1972. Up to now, 12,000 patients belonging to the Thorotrast and control groups have been researched; 600 Thorotrast patients and 600 members of the control group have been examined. The causes of death were ascertained for approximately 950 Thorotrast carriers and 800 persons of the control group. At the present time it appears that Thorotrast carriers have a higher incidence of liver tumors, liver cirrhosis, leukemias, and aplastic anemias. (auth)

631 (RISO-294, pp 163-168) SPECIAL CLINICAL FINDINGS AMONG THOROTRAST PATIENTS. van Kaick, G.; Lorenz, D.; Dringa, I. (German Cancer Research Center, Heidelberg). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

The outstanding, probably Thorotrast-induced, diseases among the 800 examined patients are four tumors of the liver, many liver cirrhoses, one case of chronic myeloid leukemia, and many long-term sequelae caused by paravascular injection. Since the liver is the most commonly injured organ of Thorotrast carriers, a step-wise diagnostic schedule was developed consisting of laboratory tests, x-ray examinations, sonography, celiac arteriography, and Laparoscopy. For the necessary follow-up studies it is hoped, in this way, to keep the diagnostic stress within tolerable limits, while obtaining satisfying diagnostic results. (auth)

632 (RISO-294, pp 175-192) THOROTRAST INJURY IN JAPAN. Mori, T.; Nozue, Y.; Miyazi, T.; Takahashi, S. (Yokohama City Univ., Japan). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Thorotrast injuries in Japan occurred after 1945, and from these 94 autopsy cases had been accumulated up to 1970. These

autopsy cases consisted of 60 cases of malignant tumor of the liver and 9 cases of blood diseases. Examination of Thorotrast-administered autopsy cases in Japan has revealed, among other things, that about one half of all Thorotrast-administered cases were war-wounded ex-servicemen and that the dates of injection in these were concentrated between 1932 and 1944. Based on this preliminary finding, a follow-up study was conducted on 147 Thorotrast-administered war-wounded ex-servicemen after a lapse of 31 to 36 years from Thorotrast injection, and 6 cases of malignant tumor of the liver, 1 case of leukemia, 1 case of thrombocytopenic purpura and 5 cases of cirrhosis of the liver were found among the samples. The incidence of these diseases in the samples was shown to be significantly higher than that in the controls. Further, a clinical examination was conducted on 45 samples from among the 147 Thorotrast-injected war-wounded ex-servicemen. In a liver function test, lowering of the protein metabolic rate and foreign body discharge function was observed, while a blood examination indicated decrease of erythrocytes, leucocytes, hemoglobin value, and thrombocyte count. These findings in the samples were significant in comparison with the controls. Finally, the total number of Thorotrast-administered persons living in Japan as of 1972 was roughly estimated at 5,000. (auth)

633 (RISO-294, pp 193-211 EPIDEMIOLOGICAL FOLLOW-UP STUDIES OF THE PORTUGUESE THOROTRAST SERIES (UP-DATED RESULTS). da Silva Horta, J.; Cayolla de Motta, L.; Tavares, M. H. (Inst. of Pathology, Lisbon). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Epidemiological studies in Portugal of about 51% of 2,500 patients injected with Thorotrast mainly for cerebral angiographies between 1930 and 1955, and of a smaller group of controls (injected for similar purposes with non-radioactive contrast drugs), were followed up until the end of 1972. The Thorotrast population has shown a gross excess of malignancies and of severe fibrosis in the liver and in the tissues around blood vessels where the drug for intravascular use has been spilled and retained. According to a statistical analysis of the Portuguese data, the excess malignancies are leukaemias and other rapidly fatal blood dyscrasias, liver tumors of which the most frequent type is the haemangioendothelioma which is practically Thorotrast specific and the total number of malignant tumors, even excluding liver tumors. There is a slight excess of lung cancer also. The findings are discussed at some length, particularly the significance of local granulomata, liver fibrosis (causing a clinical picture similar to that of liver cirrhosis), fatal blood dyscrasias, liver tumors, lung cancer, and malignant bone tumors. (auth)

634 (RISO-294, pp 212-218) LIVER STUDIES IN THE THOROTRAST PATIENTS: LABORATORY AND CLINICAL FINDINGS (STUDY OF 175 CASES). Tavares, M. H.; Saragoca, A.; da Silva Horta, J. (Univ. of Lisbon). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

In 175 non-selected patients injected with thorium dioxide laboratory tests and clinical studies were made. The clinical complaints are most often related to gastro-intestinal pathology, mainly concerning the liver. The laboratory tests disclosed a serum dysproteinemia (low albumin and increased α-2 and γ-globulin) and increased levels of alkaline phosphatase. The search for α-fetoprotein was negative in all the 10 cases in which it was possible to perform this test. Among the 25 cases with histological liver examination, 11 liver tumors were found (4 hemangioendotheliomas, 5 cholangiocarcinomas, and 2 adenocarcinomas); the remaining 14 cases disclosed hepatic fibrosis. (auth)

635 (RISO-294, pp 219-232) LIVER ULTRASTRUCTURAL FINDINGS IN PATIENTS INJECTED WITH THOROTRAST. da Silva Horta, J.; Cristina, M. L.; Baptista, A. S. (Univ. of Lisbon). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Liver biopsies from patients injected with Thorotrast were examined by electron microscopy. Alterations of the mitochondria, smooth and rough endoplasmic reticulum, bile canaliculi, and hypertrophic Golgi complexes were found. The presence of numerous multivesicular bodies is remarkable. Thorotrast structure is described. Aggregates of this material were found in the Kupffer and histiocytic cells accompanied by needle-like structures and surrounded by dense collagen. Thorotrast was seldom seen in the hepatocyte. These findings were identical in all the cases and more intense in the patient injected the longest time ago. Although it is stressed that the lesions are not specific, it is suggested that they may represent an adaptive reaction of Thorotrast. (auth)

636 (RISO-294, pp 233-247) TUMORS DEVELOPED IN PEOPLE INJECTED WITH THORIUM DIOXIDE (THOROTRAST) (PORTUGUESE EXPERIENCE). da Silva Horta, J. (Univ. of Lisbon). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

A discussion is presented of tumors appearing in patients injected with Thorotrast: 15 cases of liver hemangioendothelioma, 1 hemangioendothelioma only of the bone marrow, 1 reticulosarcoma, 9 cases of cholangiocarcinoma, 2 hepatomas, and 5 cases of tumors on the edge of large deposits of Thorotrast. All these cases were histologically confirmed from biopsy or autopsy. Comments are given concerning the genesis of such tumors. (auth)

637 (RISO-294, pp 248-258) PATHOLOGICAL FINDINGS IN THE RES (LIVER, SPLEEN, LYMPH NODES, BONE MARROW) OF THOROTRAST PATIENTS (HISTOLOGICAL AND AUTORADIOGRAPHIC INVESTIGATIONS). Wegener, K. (Univ., Heidelberg); Wesch, H.; Kampmann, H.; Zahnert, R. Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

A report is given on pathological and autoradiographical investigations of 17 patients who received intravascularly unknown quantities of Thorotrast. Various late lesions had originated: fibrosis of the liver in 7 cases, cirrhosis of the liver in 10 cases, hemangiosarcoma of the liver in 6 cases, cholangiocarcinoma and hepatocellular carcinoma in 3 cases respectively, fibrosis and atrophy of the spleen in 15 cases, benign hemangioma of the spleen in 1 case, fibrosis and atrophy of the lymph nodes near the porta of the liver in all cases, thorotrastoma in 6 cases. Thirteen patients died from complications of thorotrastosis: coma hepaticum, exsanguination, cancerous cachexis, and hemorrhagic diathesis. Four patients died from peptic ulcer, heart insufficiency, heart infarction, and embolism. In lymph nodes, bone marrow, and thorotrastomas no tumors had developed. (auth)

638 (RISO-294, pp 303-307) STABILITY OF LEUKEMOGENIC RISK IN HUMAN MARROW IRRADIATED BY α RAYS. Marinelli, L. D. (Argonne National Lab., IL). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Comparison between the latent period of leukemias and the corresponding man-years at risk in the Thorotrast-injected patients of Denmark suggests that the leukemogenic risk per unit absorbed dose of chronically delivered α-radiation remains constant in time. This result is in contrast with the decline observed in leukemias induced by x-radiation in therapeutically treated spondylitics. (auth)

639 (RISO-294, pp 308-316) DOSE EFFECT RELATIONS IN HEPATIC CARCINOGENESIS. Faber, M. (Finsen Inst., Copenhagen). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

The relative significance of radiation and physical toxicities of Thorotrast had to be solved in man. An attempt to give a risk estimate on the basis of calculated doses to the liver is presented. The results fit the published risk estimates for other types of radioinduced tumors. The procedure for the calculation of absolute risk is given. The risk is calculated to be $0.42/10^6$ persons/year/rem. (auth)

640 (RISO-294, pp 320-333) EXPECTED LATE EFFECTS IN THOROTRAST PATIENTS. Muth, H. (Universitaet des Saarlandes, Homburg, Ger.); Oberhausen, E.; Kunkel, R.; Herzfeld, U. Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

A report of the results of biophysical examinations of about 540 Thorotrast patients is presented. Measurements were made of the total-body radioactivity and of the thoron concentration in the exhaled air. Taking into account the results of special animal experiments on the patients both the dose rate as a function of the age of the Thorotrast burden and the accumulated radiation dose in different organs of the patient have been calculated. The average values as well as the upper limits of the radiation exposure of the different organs (liver, spleen, marrow-free skeleton, bone marrow, and lungs) are given. Using these data and the most probable values for risk coefficients published, the expected radioinduced late effects (leukemia, bone tumors, lung tumors, and liver tumors) in a Thorotrast group were estimated and discussed. The results show qualitatively the importance of follow-up studies of Thorotrast patients for gathering of optimal and useful radiobiological data. (auth)

641 IMPAIRED HEMATOPOIESIS THROUGH THORIUM-X THERAPY. Stieglitz, R.; Thiele, M.; Stobbe, H.; Wegener, G. (Humboldt Univ., Berlin). Folia Haematol. (Leipzig); 100: No. 1-2, 95-103(1973). (In German).

Even today thorium X is occasionally used for the treatment of Morbus Bechterew. The favorable conditions of decay and elimination are no guarantee for a treatment without dangers. The specific sedimentations after parenteral administration will cause a high short-time burden of dose in the peripheral parts of the bone-marrow. Hematological changes will appear in the course of the total cure. Even a number of panmyelophthysis and leukemia caused by a thorium X therapy have been described. Two personal observations, the appearance of a leukemia with immature cells and a hypo-plastic damage of the bone-marrow are referred to. (auth)

642 TECHNIQUE OF MEASURING OF THE ACTIVITY OF ^{239}Pu IN WOUNDS. Devyataikin, E. V. (Inst. of Biophysics, Moscow). Med. Radiol.; 18: No. 12, 61-64(Dec 1973). (In Russian).

The necessity of taking into consideration the self-absorption effect of soft radiation in particles of metallic Pu during the measurement of ^{239}Pu content in wounds is discussed. The cross section of the photoelectric absorption was calculated for photon energies of 13.6, 17.4, and 20.5 keV. A formula for the calculation of the self-absorption effect in spherical particles of metallic Pu with radius greater than 10 μm is given. (tr-auth)

643 CONGENITAL RADIOACTIVE IODINE: INDUCED STRIDOR AND HYPOTHYROIDISM. Jafek, B. W.; Small, R.; Lillian, D. L. (Univ. of California, Los Angeles). Arch. Otolaryngol.; 99: No. 5, 369-371(May 1974).

Sodium iodine I-131 is used widely in the diagnosis and treatment of various thyroid disorders. It has been implicated in several cases of infant thyroid hypoplasia when given in thyroid-ablative doses to pregnant women during the third or fourth month of pregnancy. A hypothyroid infant was born to a mother who had received 50 microcuries of sodium iodide I-131 at 13½ weeks' gestation. The resultant tracheal hypoplasia in the region of the thyroid gland with stridor and mild respiratory obstruction represents a previously unreported addition to the syndrome and is believed to be the result of radioactive nuclide uptake by the fetal thyroid. Classic cretinoid features were not present in the infant. (auth)

Animals

Refer also to abstracts 312, 572, 577, 586, 697, and 698.

644 (LF-46, pp 43-49) ABSORBED DOSE DISTRIBUTION PATTERNS IN THE BEAGLE THORAX AFTER INHALATION OF ^{90}Sr-^{90}Y FUSED CLAY PARTICLES. Snipes, M. B.; Hulbert, A. J.; Runkle, G. E.; Scott, R. T. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972-September 30, 1973.

Methods were developed to determine distribution patterns for the absorbed β dose in the beagle thorax after inhalation of an aerosol containing relatively insoluble radioactive particles. Preliminary results are reported for two beagle dogs sacrificed 8 days post-inhalation of an aerosol consisting of ^{90}Sr-^{90}Y in fused clay particles. For one dog, the ratio (observed absorbed thorax dose)/(average absorbed thorax dose) = relative dose that ranged from 0 to 3.98; for the other dog the range was 0 to 3.19. Data indicated that a significant portion of the thorax received an absorbed dose that was 3 or 4 times the average value. (auth)

645 (LF-46, pp 50-54) COPROPHAGY IN LABORATORY ANIMALS: A PRELIMINARY STUDY TO ASSESS POTENTIAL INFLUENCES TO EXCRETA INGESTION ON RADIONUCLIDE RETENTION PATTERNS. Thomas, R. L.; Roe, L. J. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972-September 30, 1973.

Rats were gavaged with $^{144}CeCl_3$ and either prevented from or allowed to practice coprophagy. Whole-body retention data varied widely and, in some instances, resulted in highly erratic patterns and enhanced gastrointestinal tract absorption of gavaged ^{144}Ce in coprophagy-allowed rats. These influences of coprophagy on whole-body retention and tissue distribution were manifested both for animals kept in wire-bottom and plastic shoe box cages; however, the magnitude of alteration varied in the two caging systems. Existence of coprophagy and its potential effects should be carefully considered in evaluating both short- and long-term results of inhalation exposure studies. (auth)

646 (LF-46, pp 61-66) PRELIMINARY ANALYSIS OF SELECTED TISSUE CONCENTRATIONS OF ^{144}Ce IN BEAGLE DOGS AFTER INHALATION OF $CeCl_3$-CsCl AEROSOLS. Cuddihy, R. G.; Boecker, B. B.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972-September 30, 1973.

Studies were conducted with aerosols of $^{144}CeCl_3$ in CsCl particles inhaled by beagle dogs to determine the ability of endocrine organs including pituitary, pancreas, adrenals, ovaries, testes, prostate, and thyroid to concentrate absorbed ^{144}Ce. With the exception of thyroid, the remaining tissue concentrations were found to be considerably less than lung and liver concentrations at all times out to 32 days post-inhalation. These organ distribution data were consistent with previously reported radiation dose-response studies also conducted with beagle dogs. Lung, liver, and skeleton related radiation-induced diseases were the only reported effects at the highest radioactivity levels inhaled. (auth)

647 (LF-46, pp 86-90) TOXICITY OF INHALED $^{90}SrCl_2$ IN BEAGLE DOGS. VIII. Redman, H. C.; Benjamin, S. A.; Boecker, B. B.; Muggenburg, B. A.; McClellan, R. O.; Pickrell, J. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972-September 30, 1973.

Studies on the metabolism, dosimetry, and effects of inhaled $^{90}SrCl_2$ in the beagle dog are continuing in an effort to provide a basis for assessing the consequences of inhaling ^{90}Sr such as might be released in certain nuclear accidents. Seventy-two dogs have been exposed to aerosols containing ^{90}Sr resulting in initial body burdens ranging from 2.6 to 280 μCi ^{90}Sr/kg. Forty-eight of these dogs are being maintained for lifetime observation. Twenty-five unexposed dogs served as controls. The long-term retained burdens in these dogs range from 1 to 120 μCi ^{90}Sr/kg. Twenty-four dogs with a mean long-term retained burden of 38 μCi ^{90}Sr/kg have been assigned to a sacrifice study. Two of these dogs and 1 control dog were sacrificed at 5 days, 1 month, and 1 year after inhalation of ^{90}Sr. To date, 38 ^{90}Sr dogs have died or have been euthanized, 6 during the first 31 days after inhalation of ^{90}Sr with bone marrow aplasia and 32 between 585 and 2964 days after inhalation of ^{90}Sr. The latter group includes 11 dogs with hemangiosarcomas, 3 with fibrosarcomas, 11 with osteosarcomas, 3 with osteochondrosarcomas, 1 with osteochondrofibrosarcomas, 2 with leukemia, 1 with a baso-squamous carcinoma, 1 with malignant giant cell tumor, 1 with an epileptic seizure, 1 with pneumonia, and 1 with cerebellar hemorrhage (4 dogs had both a hemangiosarcoma and a osteosarcoma). The skeletons of the dogs dying with neoplasms received initial radiation dose rates of 4 to 55 rads/day and cumulative doses to death of 3300 to 22,000 rads. Three control dogs have died, one at 2615 days with autoimmune hemolytic anemia, one at 2638 days with a fibrosarcoma, and one at 2740 days with a fibrinopurulent pneumonia. Serial observations are continuing on 28 surviving ^{90}Sr dogs and 19 controls. (auth)

648 (LF-46, pp 91-95) TOXICITY OF INHALED $^{144}CeCl_3$ IN BEAGLE DOGS. VII. Benjamin, S. A.; Boecker, B. B.; Hobbs, C. H.; Jones, R. K.; McClellan, R. O.; Muggenburg, B. A.; Pickrell, J. A.; Redman, H. C. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972-September 30, 1973.

Studies on the metabolism, dosimetry, and effects of inhaled $^{144}CeCl_3$ in the beagle dog are continuing in an effort to provide information that will aid in assessing the biological consequences of inhaling ^{144}Ce such as might be released in certain nuclear accidents. Studies on the tissue distribution of inhaled $^{144}CeCl_3$ have shown that the ^{144}Ce deposited in lung is translocated at a moderately rapid rate to liver and skeleton. The pattern of distribution is such that significant radiation doses are accumulated by all three tissues. Fifty-five dogs that inhaled $^{144}CeCl_3$ and 15 control dogs have been placed in a longevity study and will be observed for their lifespan. The ^{144}Ce dogs had long-term retained burdens with initial values ranging from 20 to 2900 μCi. Twenty-seven of the dogs exposed to $^{144}CeCl_3$ have died; 8 at 21 to 44 days post-inhalation with signs attributed to severe bone marrow damage and associated pancytopenia; 2 at 138 and 144 days with radiation pneumonitis; 3 at 309 to 874 days with hepatic necrosis; 1 at 510 days with marrow aplasia; 1 at 375 days with pulmonary fibrosis; and 12 at 799 to 2612 days with neoplasms or myeloproliferative disorders. In this last group, 1 dog had an osteosarcoma, 2 had squamous cell carcinomas of the maxilla, 1 of these also having a small papillary adenoma of the lung, 5 had hemangiosarcomas of the liver, 1 had a hemangiosarcoma of the nasal cavity, 2 had myelogenous leukemia and 1 had myelofibrosis with myeloid metaplasia. One control dog died with a thyroid carcinoma. Serial observations are continuing on the 28 surviving $^{144}CeCl_3$ dogs and 14 control dogs. (auth)

649 (LF-46, pp 96-99) TOXICITY OF INHALED $^{91}YCl_3$ IN BEAGLE DOGS. VI. Benjamin, S. A.; Muggenburg, B. A.; Boecker, B. B.; McClellan, R. O.; Redman, H. C. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Studies on the metabolism, dosimetry, and effects of $^{91}YCl_3$ in beagle dogs are continuing with a view of providing information that will aid in assessing the biological consequences of nuclear accidents in which ^{91}Y or other radionuclides that produce a similar radiation dose pattern may be released. Forty-two dogs with ^{91}Y initial body burdens from 64 to 1300 μCi/kg were placed in four groups with mean lung burdens of 310, 180, 75 and 40 μCi/kg. These dogs and 12 control dogs are being maintained for lifetime observation. An additional four dogs with a mean initial ^{91}Y body burden of 180 μCi/kg were placed in a sacrifice study. Eleven dogs within the highest exposure groups have died or were euthanized at 12 to 33 days after inhalation of ^{91}Y with changes related to severe bone marrow damage and associated pancytopenia. Two dogs died approximately one year after ^{91}Y inhalation with convulsive seizures that were presumed to be unrelated to the ^{91}Y exposure. Three dogs have died or were euthanized with neoplastic disease 2000 or more days post-exposure. One control dog has died. Serial observations are continuing on all surviving dogs. (auth)

650 (LF-46, pp 100-102) TOXICITY OF INJECTED $^{137}CsCl$ IN THE BEAGLE DOG. V. Muggenburg, B. A.; Benjamin, S. A.; Hobbs, C. H.; Boecker, B. B.; Jones, R. K.; McClellan, R. O.; Pickrell, J. A.; Redman, H. C. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Studies on the metabolism, dosimetry and effects of intravenously administered $^{137}CsCl$ in the beagle dog are being conducted to aid in assessing the biological consequences of exposure to ^{137}Cs such as might occur in the event of certain nuclear accidents. The effects of the chronic, relatively uniform whole-body exposure produced by ^{137}Cs are being compared with other diverse radiation dose patterns resulting from inhalation of radioactive aerosols. Sixty-six dogs were entered into the study; 6 with a mean initial ^{137}Cs body burden of 3780 μCi/kg, and 12 dogs each with mean initial ^{137}Cs body burdens of 2820, 1940, 1420, 970, and 0 μCi/kg. All six of the highest level dogs died at 19 to 33 days post-injection with cumulative whole-body doses of 950 to 1400 rads. Three dogs in the 2820 μCi/kg level died at 24 to 27 days post-injection with cumulative whole-body doses of 860 to 910 rads. One dog in the 2820 μCi/kg level and one dog in the 1940 μCi/kg level died at 77 and 81 days after injection with cumulative whole-body doses of 1300 to 1400 rads. These early deaths were attributed to severe bone marrow damage, which was reflected in an early dose-related pancytopenia. A dog injected with 1900 μCi ^{137}Cs/kg died acutely at 693 days post-injection with necropsy findings attributed to shock. A dog injected with 2800 μCi/kg died at 1594 days post-injection with aspiration pneumonitis and a dog with 2900 μCi/kg was euthanized at 1704 days post-injection with severe arthritis. A control dog died 647 days after being placed on the study with clinicopathological manifestations of an autoimmune hemolytic anemia. Forty ^{137}Cs dogs and 11 controls are surviving at 1682 to 1936 days after being placed on experiment. The surviving ^{137}Cs dogs had initial body burdens that ranged from 880 to 3000 μCi/kg and received cumulative whole-body doses of 550 to 2200 rads. Serial observations are continuing on all survivors. (auth)

651 (LF-46, pp 103-107) TOXICITY OF INHALED ^{90}Y IN FUSED CLAY IN BEAGLE DOGS. V. Hobbs, C. H.; Chiffelle, T. L.; Hahn, F. F.; Jones, R. K.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Studies on the metabolism, dosimetry, and effects of inhaled ^{90}Y in fused clay in the beagle dog are being continued with a view toward assessing the consequences of inhalation of an energetic beta emitter that has a short effective half-life in the lung. A radiation dose pattern study in which 12 dogs were sacrificed in pairs at 0, 2, 4, 6, 8, and 12 days post-inhalation exposure has been completed. A longevity study in which 89 dogs have been exposed to ^{90}Y fused clay to date with initial lung burdens ranging from 80 to 5200 μCi/kg and 12 control dogs were exposed to stable yttrium in fused clay is in progress. The ^{90}Y was retained in lung with a half-life that approximated the physical half-life with only small quantities translocated to tracheobronchial lymph nodes, skeleton, and liver. The infinite radiation doses to lung, tracheobronchial lymph nodes, skeleton, and liver, for an initial lung burden of 1000 μCi/kg of body weight were estimated to be 1600, 170, 0.54, and 0.38 rads, respectively. Thirty-eight of 39 dogs with doses to lung from 9300 to 70,000 rads have died at 7.5 to 903 days post-exposure and the one surviving dog in this dose range is showing signs of pulmonary fibrosis at 951 days post-exposure. All the dogs that have died have shown clinico-pathological features, consistent with radiation pneumonitis. The dog that died at 903 days post-exposure with a dose to lung of 11,000 rads also had 2 small pulmonary adenomas. Fifty exposed dogs with doses to lung of 1300 to 7900 rads are surviving with no significant abnormalities at 913 to 1469 days post-exposure and will be studied for the remainder of their lifespan. (auth)

652 (LF-46, pp 112-127) TOXICITY OF INHALED ^{144}Ce FUSED CLAY IN BEAGLE DOGS. VI and II. Hahn, F. F.; Boecker, B. B.; Hobbs, C. H.; Jones, R. K.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

The metabolism, dosimetry, and effects of inhaled ^{144}Ce in fused clay are being investigated in the beagle dog to aid in assessing the biological consequences of release of ^{144}Ce in a relatively insoluble form such as might occur in certain types of nuclear accidents. The toxicity of inhaled ^{144}Ce fused clay is of broad interest since it is representative of intermediate-lived beta-emitting radionuclides. Two major studies with young adult dogs (12–14 months of age at exposure) are involved: a metabolism and dosimetry study in which 24 dogs were serially sacrificed over an extended period of time; and a longevity study with 2 series of dogs; Series I with 15 dogs exposed to aerosols of ^{144}Ce in fused clay to yield initial lung burdens of 11 to 210 μCi/kg and 3 control dogs exposed to nonradioactive fused clay, and Series II with 96 dogs exposed to aerosols of ^{144}Ce in fused clay to yield initial lung burdens of 0.0024 to 66 μCi/kg and 12 control dogs exposed to nonradioactive fused clay. The ^{144}Ce in fused clay is slowly translocated from the lung to tracheobronchial lymph nodes, they exceed the lung in ^{144}Ce concentration by 100 days post-inhalation. To date, 23 dogs have died or been euthanized at 143 to 1318 days after inhalation of ^{144}Ce. The prominent findings have been radiation pneumonitis in 17 dogs that died or were euthanized at early time periods and neoplastic disease in 6 dogs that died or were euthanized at 750 days or later; 4 cases with hemangiosarcoma of the lung, 1 case with both a hemangiosarcoma and a fibrosarcoma of the lung and 1 case with both a bronchiolo-alveolar carcinoma and a hemangiosarcoma of lung. The cumulative radiation dose to the lung to time of death has ranged from 24,000 to 140,000 rads. The 103 surviving dogs include dogs with a potential for cumulative radiation exposures to lung of up to 62,000 rads. Serial observations are continuing on all survivors with special attention directed toward evaluating ^{144}Ce metabolism and dosimetry, and various clinical, pulmonary functional, hematological, serum chemical and microbiological parameters. (auth)

653 (LF-46, pp 128-136) TOXICITY OF INHALED ^{90}Sr FUSED CLAY IN BEAGLE DOGS. IV. Snipes, M. B.; Boecker, B. B.; Hahn, F. F.; Hobbs, C. H.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Studies on the metabolism, dosimetry, and effects of ^{90}Sr in fused clay in beagle dogs have continued with a view toward obtaining information on the biological consequences of inhaling this important radionuclide in a relatively insoluble form. A total of 72 dogs were exposed to achieve graded initial lung burdens (ILBs) of ^{90}Sr for the longevity study along with 12 dogs exposed to stable strontium in fused clay which are serving as controls. Of the 72 exposed dogs, 42 dogs with ILBs from 15 to 94 μCi/kg and doses to lung to death of 40,000 to 96,000 rads died from 159 to 1214 days post-exposure. Thirty-two, with ILBs of 29 to 94 μCi/kg and cumulative doses to lung to death of 40,000 to 96,000 rads, died from radiation pneumonitis and/or pulmonary fibrosis from 159 to 477 days post-exposure. Ten dogs with ILBs of 15 to 36 μCi/kg and cumulative doses to lung to death of 43,000 to 65,000 rads have died from primary pulmonary hemangiosarcomas between 644 and 1214 days post-exposure. In addition, one dog developed a bronchioloalveolar carcinoma and another had a squamous cell carcinoma in the nasal cavity. The dog which developed the squamous cell carcinoma in the nasal cavity died 1214 days post-aerosol exposure with cumulative doses to lung and nasal turbinates of 43,000 and 3400 rads, respectively. One surviving dog with an ILB of 19 μCi/kg had thoracic radiographic changes consistent with pulmonary neoplasia at 1132 days post-exposure. The remaining 29 exposed dogs and 12 controls are surviving at 704 to 1342 days post-exposure. (auth)

654 (LF-46, pp 137-140) TOXICITY OF INHALED ^{90}Y FUSED CLAY IN MICE. II. Lundgren, D. L.; Hahn, F. F.; Sanchez, A.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

The toxicity of inhaled ^{90}Y in fused clay in mice was investigated to provide data for comparison with a similar study in beagle dogs and a study in mice that had inhaled a longer half-lived, beta-emitting radionuclide, ^{144}Ce in a relatively insoluble form. A total

of 27 groups of 6 to 80 mice each (1591 mice) were exposed to aerosols of ^{90}Y in fused clay particles. A total of 790 of the mice were utilized in various sacrifice series and 801 with initial lung burdens (ILB) ranging from 1 to 136 μCi ^{90}Y were retained for lifespan observation. Control mice for lifespan observation consisted of mice either non-exposed, sham exposed or exposed to stable yttrium in fused clay. Mice with ILB greater than 30 μCi ^{90}Y died within 60 days post-inhalation exposure. In mice with ILBs of 20 to 30 μCi, 84% died by 120 days and all but one had died by 600 days. The lifespan of mice with ILB less than 20 μCi ^{90}Y did not appear to vary significantly from that of the control mice. (auth)

655 (LF-46, pp 141-145) TOXICITY OF INHALED $^{144}CeO_2$ IN IMMATURE, YOUNG ADULT, AND AGED SYRIAN HAMSTERS. I. Hobbs, C. H.; McClellan, R. O.; Benjamin, S. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Syrian hamsters were exposed to aerosols of $^{144}CeO_2$ at 28 (immature) and 84 (young adult) days of age to better define the dose-response relationships following inhalation of this radionuclide by a population with a wide range of ages such as would be the case with a human population following a catastrophic nuclear accident. Animals are also being maintained for exposure at 340 (aged) days of age. The animals are being exposed to achieve graded initial lung burdens (ILB) for each of the exposure ages of about 20, 5, 1.25, 0.31, 0.80 and 0.01 μCi and control groups exposed to stable cerium oxide. Animals are being maintained both for serial sacrifice to determine the radiation dose pattern and for lifespan observation to determine dose response relationships. The effective half-life of ^{144}Ce in the lung appears to be about 63 days for both of the ages exposed to date. This would result in a dose to lung of about 4000 rads/μCi of ILB. To date only animals with ILB of about 20 μCi in both the animals exposed at 28 and 84 days of age have died at about 100 days post-exposure with pathological findings consistent with radiation pneumonitis and pulmonary fibrosis. (auth)

656 (LF-46, pp 146-154) TOXICITY OF INHALED $^{238}PuO_2$ IN SYRIAN HAMSTERS. I. Hobbs, C. H.; Mewhinney, J. A.; McClellan, R. O.; Slauson, D. O.; Miglio, J. J. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Syrian hamsters were exposed to aerosols of $^{238}PuO_2$ in order to better define the dose response relationships following inhalation of this radionuclide. The data reported are preliminary. The animals were exposed as young adults (85 to 92 days of age) to obtain groups with graded initial lung burdens (ILB) of 720, 220, 260, 100, 9.5, 1.8, 2.1, and 0.058 nCi of ^{238}Pu and a control group. Animals are being maintained both for serial sacrifice to determine the radiation dose pattern and for lifespan observation to determine dose response relationships. To date only animals with ILB greater than 220 nCi have died. The animals have died at from 60 to 100 days post-inhalation exposure. The major pathological finding in animals that have been examined to date have been radiation pneumonitis and pulmonary fibrosis. (auth)

657 (LF-46, pp 155-162) EFFECTS OF INHALED ^{144}Ce FUSED CLAY ON THE FUNCTION AND STRUCTURE OF THE CARDIOPULMONARY SYSTEM OF THE BEAGLE DOG. Mauderly, J. L.; Muggenburg, B. A.; Hahn, F. F.; Pickrell, J. A.; Boecker, B. B.; Hobbs, C. H. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Eighteen beagle dogs inhaled aerosols of either ^{144}Ce or stable cerium in fused clay and were examined by serial pulmonary function, cardiovascular dynamics, and clinical evaluations to provide a better understanding of the relationship between functional damage and morphological alterations resulting from the inhalation of beta-emitting radionuclides. Dogs were sacrificed with slight, moderate, or severe degrees of functional loss. After sacrifice, pathological evaluations were performed. Early, non-specific functional changes indicated by measurements during treadmill exercise were found in dogs with focal inflammatory lesions. A ventilation distribution defect and early perfusion changes were seen in dogs with local septal fibrosis and proliferation of alveolar cells. A severe ventilation-perfusion imbalance was seen in dogs with advanced fibrosis and vascular changes. Functional, histological, and chemical changes were related to dose and dose rate. (auth)

658 (LF-46, pp 163-168) EFFECTS OF CURRENT AEROSOL EXPOSURE METHODS ON THE PULMONARY FUNCTION OF BEAGLE DOGS AND SYRIAN HAMSTERS. Mauderly, J. L.; Tesarek, J. E. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

The methods used in this laboratory for exposing beagle dogs and Syrian hamsters by inhalation to radionuclide-bearing aerosols incorporate means of restraint designed to maintain the animals' position, force them to breathe the aerosol mixture, and limit contamination to the area of the muzzle. The pulmonary function of six beagle dogs was measured in the standing position without sedation and in an exposure sling following administration of phenobarbital and triflupromazine HCl. Ventilation was depressed and lung mechanics were altered under exposure conditions, but intrapulmonary gas distribution and percent alveolar ventilation were not impaired. The pulmonary function of ten Syrian hamsters was measured with the subjects standing quietly, and in an exposure tube. An increase in ventilation resulted from excitement and a rise in body temperature, but a normal percent alveolar ventilation was maintained. The increased body temperature and occasional airway obstruction were thought to be responsible for hamster exposure deaths. (auth)

659 (LF-46, pp 169-172) COMPARATIVE EFFECTS OF INHALED ^{90}Y, ^{144}Ce, AND ^{90}Sr IN FUSED CLAY ON PERIPHERAL LYMPHOCYTE FUNCTION IN BEAGLE DOGS. Benjamin, S. A.; Jones, R. K. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Beagle dogs exposed by inhalation to a variety of relatively insoluble radionuclides have been found to develop persistent lymphopenia as well as primary pulmonary neoplasms. Animals exposed to longer half-life radionuclides also show functional derangement of the remaining peripheral lymphocytes. These experiments were designed to evaluate the relative effects of dose and dose rate on the development of and recovery from the lymphopenic state as well as on the relationship between the lymphopenic state and pulmonary neoplasm induction. Three groups of 4 dogs each were exposed by inhalation to ^{90}Y, ^{144}Ce, or ^{90}Sr in fused clay at activity levels which would induce lymphopenia and radiation pneumonitis, yet allow the dogs to survive to develop pulmonary neoplasms. Lymphocyte function studies are being performed on all dogs at weekly to biweekly intervals for the first 8 weeks post-exposure and monthly thereafter. Peripheral lymphocyte function is evaluated by in vitro culture and stimulation with plant mitogens. Data are available to 12 weeks post-exposure for the ^{90}Y fused clay dogs, to 8 weeks post-exposure for the ^{90}Sr fused clay dogs and to 2 weeks post-exposure for the ^{144}Ce fused clay dogs. The only significant findings to date have been in the ^{90}Y group. The ^{90}Y exposed dogs developed lymphopenia; however, the response of the remaining peripheral lymphocytes from these dogs did not differ from those of the control animals. These results differ from those obtained on lymphocytes from dogs exposed to ^{144}Ce fused clay. (auth)

660 (LF-46, pp 180-186) PULMONARY CONNECTIVE TISSUE ALTERATIONS FOLLOWING INHALATION OF ^{144}Ce FUSED CLAY AEROSOL IN BEAGLE DOGS. Pickrell, J. A.; Harris, D. V.; Pfleger, R. C.; Benjamin, S. A.; Belasich, J. J.; Jones, R. K. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Beagle dogs were exposed by inhalation to ^{144}Ce clay particles to quantitate the relationship between pulmonary radiation dose and induced fibrosis. Collagen, elastin, glucosamine and the ratio of elastin/collagen, hydroxyproline/hydroxylysine, and hydroxyproline/proline as indicators of change in connective tissue constituents were determined. Total lung collagen was partitioned into native collagen, tropocollagen and ultrafilterable hydroxyproline peptides. Increasing cumulative radiation dosage and increasing time post-inhalation exposure correlated best with increased total lung collagen. Total lung collagen increase was seen only after more than 4 months and 39,000 rads. Tropocollagen and low molecular weight hydroxyproline peptide quantities both increased at 2 months post-inhalation exposure and 20,000 to 27,000 rads. A variable elastin response apparently was not related to increasing time post-exposure or increasing radiation dose. These results indicate that collagen accumulation is the important factor in pulmonary fibrosis. In addition, although collagen synthesis and breakdown are both activated at a relatively early time period post-inhalation, it is only when the metabolic balance is altered for a protracted time that a significant increase in native collagen (scarring) occurs. The interrelationships observed in this study provide insight into the mechanism of fibrosis induced by chronic pulmonary injury. (auth)

661 (LF-46, pp 187-190) RADIATION-INDUCED LEAKAGE OF SERUM PROTEIN INTO THE LUNG OF THE BEAGLE DOG. Henderson, R. F.; Gutierrez, E. R.; Tuttle, W. C. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

To better understand the mechanism of radiation-induced lung disease, one needs a knowledge of the time sequence of events between inhalation of radionuclides and the subsequent development of pneumonitis and fibrosis of the lung. This study was made to test the hypothesis that radiation causes vascular damage which allows leakage of serum protein into the lung, which in turn leads to the appearance of cells rich in lysosomal activity and eventually to fibrosis. Twenty-seven beagle dogs were exposed to an aerosol of ^{144}Ce fused clay to achieve initial lung burdens of 45 μCi/kg body weight and then given bronchopulmonary lavages at various times after exposure through 196 days. A significant increase in serum protein in the lavage fluid was observed at 28 days after exposure and a cumulative lung burden of 6000 rads; serum leakage continued to increase through day 128 and a cumulative lung burden of 28,000 rads. This leakage was accompanied by an increase in neutrophils but not by any significant increase in macrophages, nor was there any decrease in lavagable surfactant lipid until day 128. (auth)

662 (LF-46, pp 195-201) ANTIOXIDANT EFFECT ON SYRIAN HAMSTER LUNG LIPIDS FOLLOWING INHALATION OF A ^{90}Y FUSED CLAY AEROSOL. Pfleger, R. C.; Waide, J. J.; Pickrell, J. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Syrian hamsters were exposed to an aerosol of fused clay containing ^{90}Y to determine the extent to which radiation was responsible for lipid peroxidation. On the day of exposure, the animals were divided into two groups; one group was fed a diet that contained 6% fat and the other a similar diet with 1000 ppM BHA and BHT, potent antioxidants. Spectrophotometric assay of diene conjugates 5 days post-exposure revealed that less conjugates were present in lung lipids of irradiated animals receiving the antioxidants than in animals receiving the normal diet. Assays for diene conjugation at 12, 19, and 26 days post-exposure showed that with time after the initial inhalation exposure and with time on the diets, the amount of diene conjugation decreased and did not persist beyond the ^{90}Y irradiation. This was expected since the half-life of diene conjugates is estimated to be less than 6 hrs, and the initiator of the radical reaction which produced them, the radiation from ^{90}Y, also decreases rapidly. (auth)

663 (LF-46, pp 223-229) EFFECT OF INHALED ^{90}Y IN FUSED CLAY PARTICLES ON IMMUNITY IN MICE CHALLENGED WITH LISTERIA MONOCYTOGENES. Sanchez, A.; Lundgren, D. L.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

In order to study the effect of pulmonary irradiation on lung bacterial clearance in immunized animals, mice were immunized by intravenous injection of viable Listeria monocytogenes before or after inhaling ^{90}Y in fused clay particles. Fourteen days after immunization, 6 groups of mice (immunized-irradiated, irradiated-immunized, immunized, irradiated and 2 control groups) were challenged with a lethal dose of Listeria via the respiratory route. The concentrations of Listeria in the lungs and spleens of mice were determined at 0, 4, 24, and 72 hours after challenge. Irradiation of the lung from inhaled ^{90}Y did not appear to suppress the pulmonary clearance of Listeria in mice during the first 4 hours after challenge. Twenty-four hours after challenge, there was extensive growth of Listeria in the lungs of all the mice. Some growth was apparent in the spleens of mice that were irradiated-immunized, irradiated only and in one group of controls at 24 hours. Mice in the immunized and the irradiated-immunized groups were successful in suppressing Listeria proliferation in both lungs and spleens at 72 hours after bacterial challenge. Immunized mice suppressed the growth of Listeria in their spleens while the spleens of the irradiated and the control mice had extensive bacterial invasion. Mice that had been immunized only and those immunized before and after ^{90}Y inhalation exposure, survived a lethal dose of Listeria, whereas the irradiated only and control mice had a high mortality rate. Survival was attributed to the success of Listeria immunization. It was concluded that the 10,000 rads of β radiation absorbed by the mouse lungs was not sufficient to completely suppress the immune mechanisms of the immunized mice. (auth)

664 (LF-46, pp 230-232) FREQUENCY OF CHROMOSOME ABERRATIONS IN THE BLOOD LYMPHOCYTES OF THE CHINESE HAMSTER FOLLOWING INHALATION OF $^{238}PuO_2$ PARTICLES. Brooks, A. L.; Mewhinney, J. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

To evaluate the extent to which chromosome aberrations are produced in blood lymphocytes by inhaled plutonium, Chinese hamsters were exposed via inhalation to $^{238}PuO_2$ and the chromosome of the blood lymphocytes examined for damage 25 days later. Animals with initial lung burdens of 650 to 920 nCi died with a median survival time of 16 days. Animals with initial lung burdens of 60 to 80 nCi had a 50% reduction in lymphocyte count at 25 days post-inhalation. These animals also had an aberration frequency of 0.014 aberrations/cell while pooled controls showed a frequency of 0.004 aberrations/cell. (auth)

665 (LF-46, pp 233-239) EFFECT OF $^{239}PuO_2$ PARTICLE NUMBER AND SIZE ON THE FREQUENCY AND DISTRIBUTION OF CHROMOSOME ABERRATIONS IN THE LIVER OF THE CHINESE HAMSTER. Brooks, A. L.; Retherford, J. C.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Chinese hamsters were injected intravenously with ^{239}Pu citrate or $^{239}PuO_2$ particles. There were four particle sizes injected, 0.17, 0.30, 0.44, and 0.80 μm which would vary the local radiation dose rate to the surrounding cells. Additional hamsters were injected with graded levels of activity from 6×10^{-5} to 6×10^{-3} μCi/gm using 0.30 μm $^{239}PuO_2$ particles. This changed the particle number and the average dose rate. The particles were concentrated in the reticuloendothelial system with 90% of the injected activity in the liver, 3% in the spleen, and the remainder associated with bone and bone marrow. There was particle clumping causing high local doses in all particle sizes studied. The ^{239}Pu citrate produced a linear increase in the chromosome aberration frequency with a slope of 4.8×10^{-3} aberrations/cell/rad. The aberration frequency increased with increasing average dose following injection of the $^{239}PuO_2$ particles with little evidence of an effect of particle size on the aberration frequency. (auth)

666 (LF-46, pp 244-247) EFFECT OF $^{144}Ce-^{144}Pr$ AND PARTIAL-HEPATECTOMY ON THE PRODUCTION OF LIVER TUMORS IN THE CHINESE HAMSTER. Brooks, A. L.; Benjamin, S. A.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Six hundred and fifty (650) Chinese hamsters of similar age and genetic background have been introduced into an experiment to determine the combined effect of partial-hepatectomy and intraperitoneal injection of $^{144}Ce-^{144}Pr$ citrate on the production of liver tumors. These animals were injected with activity levels from 0.036 to 0.25 μCi ^{144}Ce/gm body weight and had either no further treatment or were partially-hepatectomized at either 20 days before or 20 or 200 days after injection. Controls were subjected to a similar surgical schedule. To date, 50 animals have been sacrificed at 600 days and 237 animals at 700 days post-injection. The dose to the liver at sacrifice has ranged from 1,400 to 10,300 rads and produced from 0.40 to 3.20 chromosome aberrations/cell. In the animals sacrificed at 600 days, only one hepatocellular neoplasm was found. One hundred and sixty-two animals injected with ^{144}Ce and allowed to live another 100 days developed 26 hepatocellular neoplasms, 2 fibrosarcomas and 1 hemangiosarcoma of the liver. There have been no hepatocellular neoplasms in the 75 control animals. There was an increased incidence of hepatocellular neoplasms in animals partially-hepatectomized at 200 days following injection of 0.25 μCi ^{144}Ce/gm body weight as compared with non-hepatectomized animals. Animals injected with 0.04 and 0.05 μCi/gm and partially-hepatectomized after injection had the same tumor incidence as animals injected with 0.036 μCi/gm and no surgery. Partial-hepatectomy prior to injection with 0.036 μCi/gm appeared to decrease the incidence of liver tumors. (auth)

667 (LF-46, pp 248-253) EFFECT OF PULMONARY IRRADIATION FROM INTERNAL EMITTERS ON THE TRANSFORMATION AND KINETICS OF CANINE LYMPHOCYTES IN VITRO. Benjamin, S. A.; Brooks, A. L.; Jones, R. K. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Beagle dogs exposed via inhalation to ^{144}Ce in fused clay exhibited a profound and persistent lymphopenia and developed primary pulmonary neoplasms at 2 to 3 years post-exposure. The functional characteristics of the residual lymphocyte populations in such dogs were evaluated. Lymphocyte transformation and the kinetics of the lymphocyte response to plant mitogens in vitro were studied in ^{144}Ce exposed and control dogs. Normal Beagle dog lymphocytes responded to both phytohemagglutinin (PHA) and pokeweed mitogen (PWM) although the responses varied quantitatively. Lymphocytes from dogs with radiation-induced lymphopenia had a reduced ability to respond to both mitogens when compared with controls. Lymphocyte kinetic studies indicated that the time prior to initial DNA synthesis varied between individual cells. The kinetics of lymphocyte response to PHA and PWM also differed although it varied between dogs. This was true of lymphocytes from both irradiated and control animals. The data suggest that two different populations of canine lymphocytes may

be stimulated by PHA and PWM and that both are affected by chronic irradiation. The combined effect of the lymphopenia and the functional lymphocyte depression on the general immune response, coupled with the direct carcinogenetic effect of chronic pulmonary irradiation, could lead to early development of pulmonary neoplasms. (auth)

668 (RISO-294, pp 267-280) THOROTRAST-INDUCED SPINDLE CELL SARCOMA AND HEPATIC CHOLANGIOCARCINOMA IN SYRIAN HAMSTERS. Mori, T. (Yokohama City Univ., Japan); Okamoto, T.; Umeda, M.; Saito, K.; Okanzima, H. Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

By injecting Thorotrast into the submucosa of the cheek pouch of Syrian hamsters, spindle cell sarcomas were induced at the site of injection. It was also possible to induce hepatic cholangiocarcinoma in Syrian hamsters by systemic Thorotrast administration. Both of the induced tumors were transplantable, and could also be converted into the ascitic form. In addition, the former was established as a stable strain through culture in vitro. Histopathological and radiological examination of the tumors demonstrated that the carcinogenesis of the former proceeds from Thorotrast foreign body inflammation to thorotrastoma formation to spindle cell sarcoma development, and that of the latter from Thorotrast deposition in the liver to adenomatous proliferation of intrahepatic bile ducts to the development of hepatic cholangiocarcinoma. In both tumors, shortening of the period from Thorotrast administration to tumor recognition was observed as the Thorotrast dose was increased. Also abnormal proliferation of alveolar epithelial cells of the lung was observed following systemic Thorotrast. (auth)

669 (RISO-294, pp 294-302) EFFECT OF THOROTRAST ENRICHED WITH ^{230}Th. Faber, M. (Finsen Inst., Copenhagen). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Thorotrast enriched with ^{230}Th to an α-activity 7 to 49 times normal when injected into rabbits at a high dose (10 ml) and a low dose (0.3 ml) showed a shortened latency period for haemangioendotheliomas compared with commercial Thorotrast, demonstrating the significance of radiation in carcinogenesis. (auth)

670 (UCD-472-119) ANNUAL REPORT, FISCAL YEAR 1972. (California Univ., Davis (USA). Radiobiology Lab.). Jun 1972. Contract AT(04-3)-472. 151p. Dep. NTIS $7.60.

Separate abstracts were prepared for 22 sections of this report. Fifteen additional sections discuss the anatomy, physiology, and care of Beagle dogs. (CH)

For abstracts of individual sections see: 86, 571–577, 671–680, 731–733, and 1758.

671 (UCD-472-119, pp 66-70) MORBIDITY AND MORTALITY IN RADIONUCLIDE-TREATED BEAGLES. Chrisp, C. E.; McClatchy, C.; White, R. G.; Pharr, J. W.; Waterman, D. Jun 1972.

In annual report, fiscal year 1972.

Clinical data on radionuclide-treated beagles are summarized. Causes are given for the deaths of 12 ^{90}Sr and 24 ^{226}Ra dogs. (auth)

672 (UCD-472-119, pp 71-72) TRANSPLANTATION OF RADIATION-INDUCED LEUKEMIAS. Shifrine, M.; Wilson, F. D.; Waterman, D.; Galligan, S. J.; McNeil, C.; Holloway, G. Jun 1972.

In annual report, fiscal year 1972.

Transplantation studies on ^{90}Sr radioinduced canine myelomonocytic leukemia are discussed. The objective is to answer the following questions: Can 100% takes be obtained using fetuses ~40 to 43 days, when immune competence is low? Can leukemia be induced with irradiated leukemic cells? And can leukemic cells grown in tissue culture be used for induction of leukemia? (auth)

673 (UCD-472-119, pp 73-74) HEMATOLOGIC CHANGES WITH REPEATED TRANSPLANTATION OF ^{90}Sr-INDUCED CANINE MYELOMONOCYTIC LEUKEMIA. Wilson, F. D.; Shifrine, M. Jun 1972.

In annual report, fiscal year 1972.

A sequence of hematologic alterations in neoplastic expression occurs during serial transplantation of ^{90}Sr-induced canine myelomonocytic leukemia. (auth)

674 (UCD-472-119, pp 77-78) CHROMOSOMAL ALTERATION IN A HIGH-LEVEL ^{90}Sr-CONTAMINATED BEAGLE. Wolf, H. G.; Taylor, N. J.; Galligan, S. J. Jun 1972.

In annual report, fiscal year 1972.

Fourteen clinically normal D50-level dogs were surveyed for possible cytogenetic abnormalities. Thirteen presented normal karyograms and 1 karyogram contained an abnormal metacentric chromosome, which will be followed closely to determine subsequent disease relationship. The study is being extended to include dogs in the lower ^{90}Sr ingestion levels. (auth)

675 (UCD-472-119, pp 79-82) ALTERED HEMATOPOIESIS IN ^{90}Sr- AND ^{226}Ra-TREATED BEAGLE DOGS. Wilson, F. D.; Bryant, B. J.; Goldman, M.; Munn, S. L. Jun 1972.

In annual report, fiscal year 1972.

Myeloid/erythroid (M/E) ratios in bone marrow of Beagle dogs showed significant early depressions in high-level ^{90}Sr (D60, D50) and ^{226}Ra (R5X) dosage groups. D50 and R5X dogs evidenced a slow, progressive trend toward recovery of normal M/E values. Only D50 dogs lived long enough for full restoration. The timing of this restoration (~1500 days or 4 years of age) correlated with the timing of recovery of blood leukocytes from leukopenic levels. D50 M/E ratios were depressed similarly in pre-MPS and non-MPS-destined individuals. (auth)

676 (UCD-472-119, pp 83-85) BONE MARROW RECOVERY IN ^{226}Ra-TREATED BEAGLE DOGS: A PROVISIONAL ANALYSIS. Bryant, B. J.; Wilson, F. D.; Goldman, M. Jun 1972.

In annual report, fiscal year 1972.

Myeloid/erythroid (M/E) ratio recovery in R5X level ^{226}Ra-treated Beagle dogs was nonlinear and remained terminally incomplete. The nonlinearity reflects an uncoupling of the recoveries of PM and MM cells which, in turn, reflects a complex interaction between two factors, both of which had nonlinear patterns of declining influence including radiation-induced death of PM cells and S cell excess-induced negative feedback inhibition of the PM → MM cytodifferentiation step. (auth)

677 (UCD-472-119, pp 86-88) RADIOGRAPHIC CHANGES IN SKELETONS OF BEAGLES ADMINISTERED ^{90}Sr AND ^{226}Ra. Williams, R. J. R.; Hanson, R. J. Jun 1972.

In annual report, fiscal year 1972.

Radiographic injury scores of the skeleton were compared by dose and time in ^{90}Sr- and ^{226}Ra-treated Beagles. Dogs at the higher levels in both series developed tumors, except in the ^{90}Sr injection group. (auth)

678 (UCD-472-119, pp 89-90) TRANSPLANTATION OF ^{226}Ra-INDUCED OSTEOSARCOMAS. Shifrine, M.; Waterman, D.; Chrisp, C. E.; Wilson, F. D. Jun 1972.

In annual report, fiscal year 1972.

An attempt was made to determine the feasibility of using a dog model for the study of osteosarcoma. Tumor cells from ^{226}Ra-induced osteosarcomas were transplanted in 6 litters in utero and in 6 neonates. None of the latter developed tumors; in the former, 3 pups from 2 litters of 9 pups had osteosarcoma. (auth)

679 (UCD-472-119, pp 91-94) KARYOTYPIC ALTERATION ASSOCIATED WITH RADIATION-INDUCED AND SPONTANEOUSLY OCCURRING CANINE OSTEOSARCOMAS. Wolf, H. G.; Taylor, N. J.; Galligan, S. J.; Shimoto, K. Jun 1972.

In annual report, fiscal year 1972.

A similar pattern of hypodiploidy with the appearance of abnormal submeta- or metacentric chromosomes was observed in karyotypic alteration of both radiation-induced (^{226}Ra) and spontaneously occurring osteosarcomas in beagles. The similarity is considered more than coincidental. (auth)

680 (UCD-472-119, pp 120-123) TEMPORAL AND SPATIAL LOCAL DOSIMETRY OF ^{90}Sr–^{90}Y IN UNIFORMLY LABELED BEAGLE HUMERI. Momeni, M. H.; Goldman, M.; Worden, L. L. Jun 1972.

In annual report, fiscal year 1972.

Local radioactivity was measured and correlated with absorbed dose measurements in reconstituted Beagle humeri to estimate a geometry-distribution factor, G. This factor is a product of a physical matrix geometry factor, g_1, and a time dependent local ^{90}Sr–^{90}Y distribution factor, g_2. The G measured from the dose rate, GD_L, to bone marrow varied from 0.09 to 0.5 from proximal to midshaft humeral region for dogs at 2.0 to 8.2 yr old. (auth)

681 BLASTOGENIC EFFECT OF URANYL NITRATE ON THE PERIPHERAL LYMPHOCYTE OF THE RAT. Berke, H. L.; Palazzolo, M. J. (Wayne State Univ., Detroit). AT(11-1)-1630. Amer. Ind. Hyg. Ass. J.; 35: No. 4, 207-217 (Apr 1974).

A micro method was developed for the separation and concentration of peripheral blood lymphocytes of the rat for the purpose of observing morphological changes at frequent intervals following exposure to various noxious agents without adverse effect on the small animal. The ratio of large to small cells based on the control median diameter was used as an index of size distribution changes. When this criterion of response was applied to the uranium-poisoned animal it proved to be a very sensitive test of

the exposure. The median cell size increased almost immediately after intraperitoneal injection even at the lowest level (0.1 mg/kg of body weight), reaching peak values in about a week. This response correlated well with the dose except at the highest level (3.0 mg/kg). The toxicant induced a blastogenic effect that may be specific in terms of the cell membrane–blastogen interaction. Uranium is a more efficient blastogenic agent in vivo at least by a few orders of magnitude than is mercury in vitro. The index may also be applicable to many other toxic agents as a diagnostic test of intoxication, injury, or exposure. (auth)

682 LESIONS OF THE GASTROINTESTINAL TRACT IN DOGS IN REMOTE PERIODS FOLLOWING ADMINISTRATION OF ^{210}Po. Lebedeva, G. A. Arkh. Patol.; 35: No. 12, 39-45(1973). (In Russian).

In remote periods following subcutaneous administration of 2.5 microcurie/kg of ^{210}Po to dogs treated with oxatyol, various morphological changes, which aggravated as the time of the investigation increased, occurred in the gastrointestinal tract of the animals. Particularly considerable were disorders in the stomach and small intestine where atrophic, dystrophic, and sclerotic processes developed, accompanied by impairment of the course of physiological regeneration, formation of glandular polyps, gastric erosion, and ulcer of the small intestine. (auth)

Microorganisms

683 REPAIR REPLICATION INDUCED BY ^{3}H INCORPORATED INTO HeLa DNA. Painter, R. B.; Young, B. R. (Univ. of California, San Francisco). Mutat. Res.; 22: No. 2, 203-206(Feb 1974).

HeLa S3 cells were grown in suitable culture media supplemented with [^{3}H]dTrd for 24 h. Controls were grown in unsupplemented media. These media were removed and replaced with media containing IdUrd and incubation was continued for 1 h in order to eliminate end-to-end association of density-labeled DNA with the ^{125}IdUrd-labeled DNA that was later synthesized. Cells that had not been incubated with [^{3}H]dTrd were irradiated with 25 to 100 krad of 300 kV x rays. On the average, one disintegration of ^{3}H within DNA induced the same amount of repair replication as did 0.34 rad of 300 kV x radiation. (HLW)

Nuclide Kinetics and Toxicology

Refer also to abstract 334.

Man

Refer also to abstracts 282, 553, 625, and 643.

684 (RISO-294, pp 14-30) TISSUE DISTRIBUTION AND STEADY STATE ACTIVITY RATIOS OF ^{232}Th AND DAUGHTERS IN MAN FOLLOWING INTRAVASCULAR INJECTION OF THOROTRAST. Kaul, A. (Freie Univ., Berlin). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Published data and results of investigations on tissue distribution and steady state activity ratios of ^{232}Th and daughters in man were compiled in order to get best estimates for dose rate calculations in patients with long-term Thorotrast burdens. The average steady state activity ratios of ^{232}Th within the reticulo-endothelial-system of the standard Thorotrast patient proved to be quite comparable to those observed in animal experiments, indicating the elimination of ^{232}Th decay products in vivo from ThO_2 aggregates to be a property of Thorotrast itself rather than of the animal. (auth)

685 (RISO-294, pp 31-39) RADIATION DOSE IN LUNGS. Grillmaier, R.; Muth, H. (Universitaet des Saarlandes, Homburg, Ger.). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Fundamentals for calculating radiation doses in the different parts of the lungs of Thorotrast patients are described and doses and dose-rates depending on time after injection of the contrast medium and on the injected amount are given. (auth)

686 (RISO-294, pp 40-51) MEAN ORGAN DOSE RATES IN MAN FOLLOWING INTRAVASCULAR INJECTION OF THOROTRAST. Kaul, A. (Freie Univ., Berlin); Abmayr, W.; Hindringer, B. Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Estimates of mean organ dose rates for patients with long-term burdens of intravascularly injected Thorotrast (10, 30, and 50 ml) were performed based on present best estimates on tissue distribution and steady state activity ratios of ^{232}Th and daughters. Self-absorption of emitted radiation due to aggregation of the ThO_2 particles within the living tissues was considered by application of conventional methods of empirical origin. In addition, long-term (0, 125–392 days) animal experiments were done with rabbits, considering the size of the ThO_2 aggregates in vivo, and their variation with time in tissues of the reticuloendothelial system, by analyses of histological sections using a picture analysing computer (flying spot analysis). For an intravascular injection of 50 ml Thorotrast the mean α dose rate in the liver, spleen, and bone marrow proved to be about 40, 120, and 23 rd/year respectively. The corresponding self-absorption correction factors for α particles yielded 0.52, 0.29, and 0.87, respectively, if calculated according to conventional methods. By computerized picture analyses of rabbit tissue samples (liver and spleen) containing ^{232}Th at comparable concentrations self-absorption correction factors have been calculated, which proved to be approximately 0.6 and 0.45, respectively. Moreover, the results of the animal experiments indicated the process of aggregation of ThO_2 particles within the liver tissue to be continuing for times of more than 400 days after Thorotrast injection. In the spleen, however, the aggregate size distribution remained nearly constant at times of more than about 150 days after Thorotrast application. (auth)

687 (RISO-294, pp 52-60) ASSESSMENT OF ORGAN DISTRIBUTION OF THORIUM BY NEUTRON-ACTIVATION-ANALYSIS. Wesch, H.; Kampmann, H.; Wegener, K. (German-Cancer-Research Center, Heidelberg). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

The thorium content of 2500 specimens was determined by means of neutron activation analysis. The samples were taken from different regions of the body from 17 Thorotrast patients after death. The highest concentrations were found in the main organs of the RES (up to 90 mg Th/g). The lowest concentration was found in the brain (0.05 μg/g). The variations of thorium within the organs were remarkable. In the liver of one patient the variation could be up to a factor of 50, in the bone marrow up to 100, and in the lymphatic nodes up to 1000. (auth)

688 (RISO-294, pp 81-94) THORIUM SERIES RADIONUCLIDES IN COMPACT BONE OF THOROTRAST CASES: RESULTS OF MEASUREMENTS AT IAEA. Dudley, R. A. (International Atomic Energy Agency, Vienna). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

The activity of thorium-series radionuclides in compact bone of Thorotrast cases offer a possibility of extracting skeletal dose-effect relationships in this population for comparison against similar data from populations containing ^{226}Ra, ^{228}Ra, or ^{224}Ra. Estimates of activity levels in compact bone can be obtained directly from measurements on such tissue collected at autopsy, or indirectly from measurements on the release of radium isotopes from the primary Thorotrast deposits in other tissues combined with calculations of skeletal deposition based on the new ICRP model of alkaline earth metabolism in adult humans. Autopsy samples from 5 Thorotrast cases have been measured in the laboratory of the IAEA. The results of these measurements suggest that: (1) ^{232}Th concentrations (nCi/g wet tissue) in compact bone are about 1% of those in liver, (2) ^{228}Ra and ^{224}Ra translocate to compact bone in amounts about equal to or less than those predicted by the ICRP model, and (3) ^{228}Th translocates to compact bone at dosimetrically inconsequential levels. The measured compact bone activities reside near the low end of the spectrum of previously reported results. (auth)

689 (RISO-294, pp 95-103) SKELETAL DOSE FROM ^{224}Ra FOLLOWING INTRAVASCULAR ADMINISTRATION OF THOROTRAST. Rowland, R. E.; Rundo, J. (Argonne National Lab., Il). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

With the use of a set of best estimates of the distribution of ^{232}Th and its daughters in the marrow-free skeleton following intravenous administration of Thorotrast, the dose to bone from translocatable ^{224}Ra was calculated. Translocatable ^{224}Ra is that radium created in vivo that is free to translocate, i.e., equivalent to systemically injected radium. The accumulated dose to bone from this ^{224}Ra 25 years after injection of 25 ml of Thorotrast is of the order of 25 rads. A linear dose-effect relationship for the appearance of bone

tumors in man has been postulated from the observed tumor incidence in the series of patients injected with ^{224}Ra in Germany. This linear hypothesis predicts more bone tumors in Thorotrast cases than are observed, implying either that the relationship is not linear at low doses, or that at very low dose rates the effect per rad is lower than predicted. (auth)

690 APPRAISAL OF QUANTITY OF ABSORBED DOSES OF RADIATION DURING INTRAVENAL APPLICATION OF SELENITE $Na_2{}^{75}SeO_3$. Textoris, R.; Pokorna, I. Cesk. Radiol.; 27: No. 5, 295-298(Sep 1973). (In Czech).

The suitability of the application of selenite $Na_2{}^{75}SeO_3$ for the tumor diagnosis from the point of view of radiation load of the organism was studied. Kinetics of the radio-drug was followed in two examined patients by means of external detection. On the basis of measured values according to the method of MIRD there were calculated middle absorbed doses for kidneys, liver, lungs, thyroid gland, bone marrow, gonads, and whole body. (auth)

691 BINDING CAPACITY OF ERYTHROCYTES FOR URANYL IONS. Drazanova, S.; Nosek, J. Cas. Lek. Cesk.; 112: 1364-1366(2 Nov 1973). (In Czech).

In vitro binding capacity for uranyl ions of erythrocytes was investigated. It was shown that with increasing concentration of uranyl ions in the medium, more uranium was bound by the erythrocytes. The relationship was exponential and held true up to 4.4 μg of uranium/ml of suspension. At that concentration the binding capacity of erythrocytes for uranium ions was saturated. From very diluted solutions of uranyl salts, the uranyl ions were bound by the erythrocytes even against concentration gradient. The maximum binding capacity of erythrocytes for uranyl ions was compared with the significantly elevated content of uranium in the erythrocytes from the uranium mines workers and it was found that the order of uranium amount in the erythrocytes of the miners was one-tenth of that of the maximum binding capacity of erythrocytes. (auth)

692 BINDING CAPACITY OF ERYTHROCYTES FOR URANYL IONS IN THE BLOOD OF MINERS WORKING IN URANIUM MINES. Drazanova, S.; Nosek, J. Cas. Lek. Cesk.; 112: 1366-1369(2 Nov 1973). (In Czech).

The binding capacity in vitro of the red blood cells of miners working in deep uranium mines towards the uranyl nitrate was studied. A significant decrease of the binding capacity of the red blood cells towards uranyl ions in the blood of miners was ascertained. In comparison with a control group, this capacity was lowered in average of about 57%. Possible causes of this change were discussed, namely progressive change in the biological structure of the red blood cell-membrane in the blood of miners and gradual saturation of these membranes by the uranyl salt. In further experimental studies the authors give evidence about the involvement of both causes, which disclose a characteristic timed course. (auth)

693 METHOD OF PROTEIN MULTIFRACTIONATION IN NON-CONCENTRATED URINE AS A DIAGNOSTIC CONTRIBUTION TO NUCLEAR MEDICINE. Alessandrino, L. (CNEN, Rome). Med. Lavoro; 63: No. 11-12, 1-7(1972). (In Italian). (RT/PROT-(73)27).

An electrophoretic technique was developed that allows the separation of proteins in non-concentrated urine, by means of a special support of gelatinized cellulose acetate. The method, which is easy to perform and is therefore within reach of many factory services of occupational medicine, has a high diagnostic significance, and is therefore of great interest especially in the radiation monitoring of personnel exposed to the risk of radioactive contamination. (auth)

694 CLEARANCE AND EXTRACTION OF RADIOACTIVE COLLOIDAL GOLD IN CIRRHOTIC PATIENTS. Their Modification by Gelatin. Lebrec, D.; Sleot, C.; Benhamou, J. P. (Hospital Beaujon, Clichy, France). Biol. Gastro-Enterol.; 6: 41-48 (1973). (In French).

Colloidal radiogold fractional clearance and extraction, and fractional hepatic blood flow calculated from fractional clearance and extraction were measured in controls and in patients with cirrhosis. Radiogold fractional clearance, extraction and fractional hepatic blood flow were significantly lower in cirrhotics [respectively 0.079 ± 0.028 min^{-1} (mean ± 1 SD), 28 ± 10p. 100, 0.254 ± 0.059 min^{-1}, than in controls, respectively 0.167 ± 0.049 min^{-1} 52 ± 13 p. 100, 0311 ± 0.086 min^{-1}]. There was no significant correlation between radiogold fractional clearance and hepatic blood flow assessed with the indocyanin green method. In cirrhotics fractional hepatic blood flow assessed with the radiogold method seems to overestimate hepatic blood flow assessed with the indocyanin green method; this overestimation is probably related to extrahepatic uptake of radiogold. Radiogold fractional clearance decreased (approximately 50 p. 100) following intravenous injection of gelatin in controls and in cirrhotics; this decrease is due to competition between radiogold and gelatin particles for their uptake by Kupffer cells. The fact that the decrease induced by gelatin was not different in cirrhotics and in controls suggests that the phagocytic function of Kupffer cells is not altered in cirrhosis. It seems therefore reasonable to attribute the decreased removal efficiency for radiogold observed in cirrhosis to intrahepatic shunts rather than to Kupffer cell dysfunction. (auth)

695 CORRELATION BETWEEN THE INDICES OF PERCENTAGE OF ^{131}I UTILIZATION BY THE THYROID, BASIC METABOLISM, PROTEIN-BOUND IODINE, AND VARIOUS COMPONENTS OF GLYCOPROTEIDS IN THE BLOOD SERUM OF PATIENTS SUFFERING FROM THYROTOXICOSIS. Kuz'mak, N. I. Probl. Endokrinol.; 20: No. 1, 28-32(1974). (In Russian).

The results are presented of studies of radioiodination of the thyroid, BMR, sialic acids, seromucoids, hexosamines and hexoses bound with blood proteins in 28 healthy persons and 172 patients with thyrotoxicosis of various severity. Correlation between the tests under study was determined on the basis of the material obtained. In all groups of patients a positive statistically significant correlation between the changes in percentage of ^{131}I utilization by the thyroid and protein-bound iodine was revealed in all groups of patients. This regularity between the changes in other test indices was revealed only in severe toxicosis, and more seldom – in thyrotoxicosis of moderate severity. A conclusion was drawn that the most specific and sensitive methods of functional diagnosis were radioiodination of the thyroid and determination of protein-bound iodine in the blood serum. Because of accessibility and simplicity of determining BMR and various blood glycoproteid components these tests could be recommended as auxiliary in the diagnosis of thyrotoxicosis. (auth)

696 PHYSIOPATHOLOGY OF CONTAMINATION BY PLUTONIUM: FUNDAMENTAL CONCEPTS. Lara Saenz, D.; Ramos, E. Energ. Nucl. (Madrid); 17: No. 84, 261-282(1973). (In Spanish).

The distinct parameters that intervene in physical, chemical, and biological processes involved in internal contamination by Pu are analyzed. The basic biological concepts integrating these processes are examined. The distribution, mobilization, and incorporation dynamics in organs and tissues and the biological consequences of Pu toxicity are studied. The general orientations for the evaluation of the internal contamination and elimination therapy are outlined. (tr-auth)

Animals

Refer also to abstracts 312, 581, and 733.

697 (BNWL-SA-4566) SOLUBILITY CHANGES OF ^{239}Pu OXIDE IN WATER SUSPENSION AND EFFECT ON BIOLOGICAL BEHAVIOR AFTER INHALATION BY BEAGLE DOGS. Park, J. F.; Catt, D. L.; Craig, D. K.; Olson, R. J.; Smith, V. H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1973. Contract AT(45-1)-1830. 6p. (CONF-730907-25). Dep. NTIS $4.00.

From third international congress of the International Radiation Protection Association meeting; Washington, District of Columbia, USA (9 Sep 1973).

Beagles were exposed to aerosols of $^{239}PuO_2$ or $^{238}PuO_2$ prepared by identical methods of calcining the oxalate at 750°C for 2 hrs. The PuO_2 was stored in water suspensions of 2 to 3 mg PuO_2/ml for various periods until required for exposure at which time suspensions of suitable concentrations were prepared by dilution of the stock. Aerosols were generated by nebulizing these suspensions. Ultrafilterability of the $^{239}PuO_2$ suspension remained stable ranging from 0.1 to 0.2% over a 16 month period. Dogs exposed to $^{239}PuO_2$ during this time and sacrificed 30 to 140 days postexposure had more than 98% of the body burden at death in the lungs and thoracic lymph nodes. Dogs exposed to $^{238}PuO_2$ 6 months after preparation of the stock suspension had 64% and 50% in the lungs and thoracic lymph nodes, with 23% and 34% in the skeleton and 8% and 11% in the liver at 30 and 90 days postexposure, respectively. Ultrafilterability of the stock $^{238}PuO_2$ suspension was 25%. X-ray diffraction analyses of the $^{238}PuO_2$ and of freshly prepared $^{238}PuO_2$ yielded the expected peaks, but the $^{238}PuO_2$ that had been in water suspension for 9 months showed no X-ray peaks. Dogs exposed to freshly prepared $^{238}PuO_2$ with 0.2% ultrafilterability showed more than 98% of the Pu in the lungs and thoracic lymph nodes 30 and 60 days postexposure, while the ultrafilterability of the water suspension changed from 0.2% to 16%

during the 60-day postexposure period. Radiation damage to $^{238}PuO_2$ may be responsible for the differences in the behavior of $^{238}PuO_2$ and $^{239}PuO_2$ in water suspension and in vivo. (auth)

698 (LF-46) ANNUAL REPORT OF THE INHALATION TOXICOLOGY RESEARCH INSTITUTE, OCTOBER 1, 1972–SEPTEMBER 30, 1973. McClellan, R. O.; Rupprecht, F. C. (eds.). (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. (USA)). Dec 1973. Contract AT(29-2)-1013. 350p. Dep. NTIS $10.60.

Separate abstracts were prepared for 46 sections of this report. Three additional sections discuss the physiology of canine and human lungs. An abstract of one section appeared in NSA previously as number 27: 24999. (CH)

For abstracts of individual sections see: 193, 194, 340, 433, 570, 644–667, and 699–715.

699 (LF-46, pp 10-15) IMPROVED SYSTEM FOR EXPOSURE OF BEAGLE DOGS TO RADIOACTIVE AEROSOLS. Raabe, O. G.; Newton, G. J.; Mewhinney, J. A.; Boecker, B. B.; Bowen, L. E. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

A new apparatus is described for individually exposing beagle dogs to radioactive aerosols for periods up to two hours. The system utilizes a whole-body plethysmograph for measuring the dog's respiratory activity during the exposure. The dog is restrained in the plethysmograph and only the nose is exposed to the radioactive aerosol. Provision is made for aerosol generation, for heat treatment of the aerosol, if necessary, and for sampling for aerosol characterization with a cascade impactor, a filter, and an electrostatic precipitator. (auth)

700 (LF-46, pp 37-42) BIOMATHEMATICAL MODEL OF INHALATION EXPOSURES TO AEROSOLS OF CERIUM. Cuddihy, R. G.; Gomerz, S. R.; Pfleger, R. C. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Retention and distribution patterns of ^{144}Ce were studied in beagle dogs following inhalation of $^{144}CeCl_3$ in CsCl aerosols and of $^{144}CeCl_3$ aerosols alone. Lung retention was greater after inhalation of $CeCl_3$ alone, however, ^{144}Ce absorbed into blood was distributed between liver, skeleton, and other soft tissues in a similar manner for both aerosols. Tissue retention and excretion were described by a first order, mathematical model using a single set of tissue exchange rate constants for both aerosol forms except for lung clearance rates. (auth)

701 (LF-46, pp 55-60) INFLUENCE OF AEROSOL PRODUCTION TEMPERATURE ON RETENTION OF INHALED AND INJECTED ^{144}Ce-CLAY PARTICLES IN MICE. Thomas, R. L.; Kanapilly, G. M.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Results of previous studies have indicated differences in retention of various relatively insoluble aerosols. To evaluate the influence of temperature of aerosol formation on particle retention kinetics, 9 groups of 15 mice each were exposed to ^{144}Ce-clay aerosols heated at 5 temperatures from 90 to 1150°C when passed through quartz heating columns of two different sizes at 2 flow rates. Nine groups of 5 mice each were intramuscularly injected with particles resuspended from filter samples collected during the inhalation exposures. Additional filter samples, collected during each of the inhalation exposures, were subjected to in vitro dissolution study, using a serum simulant solvent in a parallel flow system. Early respiratory tract clearance of inhaled particles, primarily representing upper respiratory tract deposition, was related to particle size. Smaller particles produced at lower temperatures were retained to a greater extent than larger particles produced at high temperatures. Following injection, particles produced at higher temperatures were retained with the greatest tenacity. Tissue distribution data collected at 32 and 64 days post-inhalation exposure clearly demonstrated more rapid dissolution and subsequent translocation to internal body organs of lower-temperature produced aerosols. (auth)

702 (LF-46, pp 67-70) DISTRIBUTION AND EXCRETION OF ^{137}Cs FOLLOWING INHALATION OF MONODISPERSE PARTICLES OF ^{137}Cs FUSED CLAY. Boecker, B. B.; Davis, J. H.; Newton, G. J.; Thomas, R. G. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

A short-term study of the behavior of monodisperse, ^{137}Cs-labeled, fused clay particles following inhalation by beagle dogs was conducted to study the effect of particle size on deposition and retention. The particles used were separated with a Lovelace Aerosol Particle Separator (LAPS) and had aerodynamic diameters of 1.2, 2.1, and 3.9 μm. Three dogs were exposed to each size aerosol and sacrificed at 0, 4, and 32 days post-exposure. In contrast to results presented previously for this aerosol, most of the ^{137}Cs deposited initially in the lung remained there with little absorption to the systemic circulation. The highest absorption was seen in the dogs exposed to the 3.9 μm particles where up to 9% of the body burden could be attributed to absorbed activity. (auth)

703 (LF-46, pp 71-77) RETENTION OF ^{137}Cs-FUSED CLAY PARTICLES IN RATS AND HAMSTERS AS A FUNCTION OF MULTIPLET: SINGLET RATIO. Thomas, R. G.; Thomas, R. L. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

One of the obstacles in achieving certain specified lung burdens of monodisperse particles in a short exposure time inhalation is the limitation placed upon the concentration of starting material in the aerosol generator. As the concentration of pre-formed particles in the generator suspension is increased, the probability of more than one particle per droplet increases, and doublet or multiplet formation occurs. If the biological behavior of these multiplet particles is not different from that of singlets, then the effect is not important. A study was undertaken in which the degree of multiplet formation was graded, to see if an effect on metabolism would result. Monodisperse fused montmorillonite clay particles were nebulized from aqueous suspensions of three different concentrations. One suspension contained only ^{137}Cs-labeled particles and gave an aerosol multiplet: singlet ratio of 0.044. The other two suspensions had unlabeled fused clay particles of similar size added to give multiplet: singlet ratios of 0.14 and 0.17. Hamsters and rats were exposed to each of three aerosols and whole-body and tissue measurements were made at various times post-exposure. Suspensions of the filter-collected aerosols from each run were also injected intramuscularly into both species for retention determination. The latter studies gave a consistent specific solubility constant, k, for all three groups of $\sim 1.1 \times 10^{-6}$ gm/cm^2/day. Long-term retention half-lives in all hamsters following inhalation were treated as one population, and gave a value of 100 days. For rats treated similarly, the long-term half-life was ~170 days. Approximately 95% of the long-term body burden was associated with lung and most of the remainder was in the carcass, presumably in bone. (auth)

704 (LF-46, pp 78-80) INITIAL LUNG DEPOSITION FOLLOWING INHALATION OF THREE SIZES OF MONODISPERSE $^{238}PuO_2$ AEROSOLS IN THE BEAGLE DOG. Mewhinney, J. A.; Miglio, J. J.; Hobbs, C. H.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

A study was conducted to define inhalation exposure parameters and to determine initial pulmonary deposition and distribution of $^{238}PuO_2$ monodisperse aerosols in the beagle dog lung immediately after inhalation exposure. Three monodisperse particle sizes of $^{238}PuO_2$ aerosol were used to expose 27 beagle dogs. The animals were sacrificed at 2 hours post-inhalation exposure. Samples of the aerosol obtained during animal exposure indicated a slight deviation from expected size of the aerosol and its monodispersity. Initial pulmonary deposition expressed as a percent of the inhaled aerosol deposited in lung was 20.5, 31.6, and 26.5 percent for 0.75, 1.5, and 3.0 μm AD $^{238}PuO_2$ particles, respectively. Distribution of activity among the 6 lung lobes was only slightly different from the distribution of activity following inhalation of several fused clay polydisperse aerosols. (auth)

705 (LF-46, pp 81-85) CHOICE OF THE BEAGLE DOG AS A LABORATORY ANIMAL. Boecker, B. B. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

The advantages of using Beagle dogs in studies of the long-term biological effects of internally deposited radionuclides are reviewed. General characteristics which favor the use of the beagle dog as an experimental animal include its intermediate lifespan, medium body size, short hair coat, friendly temperament, ease of handling, and good litter sizes. It has been well characterized in a number of laboratories. Fatal diseases in the beagle dog are diverse and not overshadowed by one predominant cause as is seen in some species. In inhalation toxicology studies, aerosol deposition patterns have been shown to be similar to those seen in humans. Also, particle size differences in the deep lung and subsequent retention in the lung differ from those seen in rodent species. The dog forms an important link in the extrapolation of results from laboratory animals to man. It is also large enough that possible therapeutic procedures for man such as bronchopulmonary lavage can be examined and tested in detail. (auth)

706 (LF-46, pp 191-194) REPLACEMENT TIME FOR LIPIDS REMOVED BY PULMONARY LAVAGE: EFFECTS OF

MULTIPLE LAVAGE ON LUNG LIPIDS. Henderson, R. F.; Waide, J. J.; Pfleger, R. C. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Pulmonary lavage has proved an effective therapeutic measure for the removal of inhaled radionuclides. Daily and hourly pulmonary lavages were performed on beagle dogs to determine the time required to completely replace lipids lost from the lung by lavage and to observe the effects of frequent multiple lavages on lung lipids. The replacement time for lipids lost by lavage was about five hours. Multiple daily lavage increased rather than decreased both the total lipid and the surfactant lipid content of the lung. (auth)

707 (LF-46, pp 219-222) IN VITRO MIGRATION OF ALVEOLAR MACROPHAGES FROM DOGS THAT INHALED ^{144}Ce FUSED CLAY PARTICLES OR $^{239}PuO_2$. Hahn, F. F.; Muggenburg, B. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Alveolar macrophages are an important constituent of pulmonary defense mechanisms and any decrease in their function such as might be produced by radiation may be detrimental to the integrity of the lung. The effect of α and β irradiation from inhaled radioisotopes on the in vitro migration of lavaged cells from beagles was examined. Cells obtained from lavage of the lungs of dogs exposed to either ^{144}Ce fused clay aerosols or $^{239}PuO_2$ aerosols were tested at various intervals from 2 to 56 days post-inhalation exposure. Inhalation of ^{144}Ce fused clay did not significantly affect the in vitro migration of lavaged cells at any time tested from 1 to 56 days post-exposure. However, inhalation of $^{239}PuO_2$ did significantly depress migration at all times tested, 2, 7, 10, 14, 21, 28, 36, 42, and 49 days post-exposure. A possible mechanism relates to α radiation-induced cell death, and release of inhibitory factor from dead or dying cells. (auth)

708 (LF-46, pp 240-243) DISTRIBUTION AND RETENTION OF MONOMERIC ^{239}Pu CITRATE IN THE CHINESE HAMSTER AND ITS CYTOGENETIC EFFECT ON THE TESTES. Brooks, A. L.; Mead, D. K.; Peters, R. F. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

Chinese hamsters were injected intravenously with ^{239}Pu citrate to characterize the retention and distribution of this chemical form of the isotope. These data were used to make an estimate of the radiation dose to the testes which was related to the chromosome damage recorded in mitotic metaphase cells. Injected ^{239}Pu citrate in the monomeric form was retained in the Chinese hamster with a long effective half-life. At day zero, the liver and bone each contained 40% of the sacrifice body burden; the remaining 20% was in the soft tissues and kidney. The liver activity, expressed as a percentage of the sacrifice body burden, increased with time whereas the bone remained almost constant. This long effective half-life in the liver is similar to that seen in dog and man and indicates that the Chinese hamster may be a useful small animal model for studying the retention, clearance and biological effects of ^{239}Pu in the liver. There was no significant increase in the frequency of chromosome aberrations in the testes at 64 days after injection, indicating that the genetic risks from ^{239}Pu citrate are small compared to the risk for life shortening and cancer induction. (auth)

709 (LF-46, pp 255-260) BRONCHOPULMONARY LAVAGE AND DTPA TREATMENT FOR THE REMOVAL OF INHALED ^{239}Pu AEROSOLS OF VARIED SOLUBILITY IN BEAGLE DOGS. Muggenburg, B. A.; Miglio, J. J.; Mewhinney, J. A.; Slauson, D. O.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

The efficacy of bronchopulmonary lavage and chelation therapy for removing ^{239}Pu following inhalation of ^{239}Pu aerosols of differing in vivo solubility character in beagle dogs were tested. The four aerosols used were nebulized from a solution of $^{239}PuCl_4$ and heat treated at temperatures of 325, 600, 900, and 1150°C. Six beagle dogs were exposed to each of the four temperature aerosols and subsequently 3 dogs in each group were treated by lavage and intravenous DTPA and 3 dogs served as controls. The treated animals received 10 unilateral bronchopulmonary lavages during the period 2 to 49 days post-exposure and 18 intravenous injections of the chelating agent diethylenetriaminepentaacetic acid (DTPA) over the experimental period of 56 days. Complete results are available for tissue distribution of ^{239}Pu on all dogs in the study and complete excreta results are available for one treated and one control dog exposed to aerosols treated at 325 and 1150°C. Bronchopulmonary lavage removed 37 and 54% of the initial lung burden of ^{239}Pu for the 325 and 1150°C treated aerosols, respectively. Urinary excretion of ^{239}Pu was increased by DTPA therapy at both aerosol treatment temperatures. Deposition of ^{239}Pu in liver and bone following solubilization in the lung was significantly depressed by DTPA therapy in the dog exposed to the 325° aerosol; at an aerosol treatment of 1150° only minute quantities of ^{239}Pu were solubilized in the lung and hence the effect of DTPA therapy on deposition in liver and bone was difficult to assess. (auth)

710 (LF-46, pp 261-274) REMOVAL OF INHALED ^{144}Ce IN FUSED CLAY FROM BEAGLE DOGS BY BRONCHOPULMONARY LAVAGE INITIATED AT VARIOUS TIME INTERVALS POST-EXPOSURE. Felicetti, S. A.; Silbaugh, S. A.; Muggenburg, B. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

The effect of time after a single inhalation exposure to ^{144}Ce on the efficacy of bronchopulmonary lavage to remove relatively insoluble radioactive particles from the lung was studied. Twenty-seven beagle dogs were exposed to aerosols of ^{144}Ce fused clay and obtained initial lung burdens ranging from 45 to 72 μCi/kg. One dog had a lung burden of 22 μCi/kg. The dogs were divided into eight groups of three dogs per group and each group was given a single bronchopulmonary lavage of the right lung at one of the following times post-exposure: 2 hours, 2, 4, 7, 14, 28, 56, and 128 days post-exposure, respectively. Median percentages of the initial lung burden recovered in the fluid of the last 7 lavages were: 12.9, 10.9, 10.1, 12.0, 5.6, 8.0, and 5.5%, respectively. Lavage was followed by sacrifice and complete dissection. The remaining 3 dogs will be lavaged at 196 days post-exposure. In dogs sacrificed at 56 and 128 days and scheduled for sacrifice at 196 days post-exposure, ^{144}Ce was eliminated with a mean effective half-life of 161 days. The results indicate that a sizeable percentage of the insoluble particles in the lung remain accessible to removal by bronchopulmonary lavage at periods exceeding 128 days post-exposure. However, increasing translocation from the lungs to other tissues occurs with time. Also, the total radiation dose delivered to lung prior to lavage becomes so large at longer times post-exposure that removal of material from the lung has little effect in reducing total cumulative dose to tissues. (auth)

711 (LF-46, pp 275-279) EFFECT OF FLOW RATE OF LAVAGE FLUID ON THE EFFICACY OF BRONCHOPULMONARY LAVAGE. Felicetti, S. A.; Silbaugh, S. A.; Muggenburg, B. A.; Benjamin, S. A. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

A method of bronchopulmonary lavage was developed for use in the beagle dog in studies on the removal of radioactive particles from the lung. The effect of the rate at which fluid is introduced into the lung on the effectiveness for bronchopulmonary lavage for removal of radioactive particles from the lung was investigated. The study was performed in six adult beagle dogs which were exposed by inhalation to an aerosol of ^{144}Ce in fused clay particles. Four of the dogs were treated with bronchopulmonary lavage of the right and left lungs on day 2 post-exposure. Two of the dogs were untreated and used to determine the distribution of the inhaled aerosol between the right and left lung. Two flow rates of the lavage fluid were used, 0.67 L/min and 1.7 L/min. The right lung was lavaged at the faster rate in 2 dogs resulting in the removal of 15 and 16% of the initial lung burden (ILB), respectively. The right lung was lavaged at the slow rate in the other 2 dogs resulting in the removal of 21 and 22% of the ILB, respectively. Bronchopulmonary lavage of the left lung of all 4 dogs, 2 at the fast rate and 2 at the slow rate resulted in the removal of 9%, 10%, 9%, and 12%, respectively. The use of the slower rate of introduction of lavage fluid increased the removal of radiocerium from the right lung but not the left lung. The order in which the lungs were lavaged did not influence the amount of radiocerium removed. Total recovery of the initial lung burden from each dog ranged from 24 to 39%. (auth)

712 (LF-46, pp 281-283) CONCEPTUAL MODEL OF THE AIRWAY BRANCH FOR USE IN MORPHOMETRY OF THE MAMMALIAN LUNG. Phalen, R. F.; Yeh, H. C.; Raabe, O. G. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 10, 1973.

Recent interest in the mammalian lung as both the site of initial deposition of inhaled materials and as the primary target organ for several environmentally induced disease processes has established a need for improved information on the anatomy of the airways. A conceptual model of the basic unit of the mammalian tracheobronchial tree which consists of three segments forming an airway branch is described. Salient features of the model include unique identification numbers for each branch segment, branching angles, airway segment lengths and diameters, inclinations of segments to gravity and radii of curvature at bifurcations. The model, designed to be realistic, unambiguous, compatible with computer

applications and flexible in that anomalous anatomical structures can be classified and noted, has proven useful in morphometric studies of human, beagle dog, rat, and Syrian hamster lung airways. (auth)

713 (LF-46, pp 284-289) EVALUATION OF LUNG CASTS BY A STEREO X-RAY METHOD. Yeh, H. C.; Hulbert, A. J.; Phalen, R. F.; Velasquez, D. J.; Harris, T. D. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

An accurate description of the anatomical details of the respiratory airways of man and experimental animals is essential to understanding the deposition and ultimate toxicity of inhaled particles. A technique for visualizing changes in airway dimensions during the preparation of an airway cast and for evaluating the fidelity of the cast is described. The lung of the animal to be cast was insufflated with powdered tantalum to provide contrast during airway radiography. The lungs were cast either by a saline replacement technique using an excised lung or a saline replacement in situ technique. Stereoscopic and monoscopic bronchograms were taken before, during and after the casting. By examination of the monobronchogram series, changes in airway dimensions during the lung casting were evaluated and analyzed. A computer program was developed from geometrical considerations to analyze the stereo bronchogram and to evaluate the lung cast. Results of the airway changes of rat lungs during the two lung casting techniques are given. Changes in airway lengths and bifurcation angles were less than 5% when using the in situ technique and considerably greater when using the excised lung; the diameters of major bronchi increased about 15% for both casting techniques. (auth)

714 (LF-46, pp 291-294) RETENTION PATTERNS IN BEAGLE DOGS REPEATEDLY EXPOSED TO AEROSOLS OF ^{137}Cs-LABELED FUSED CLAY PARTICLES. Thomas, R. G.; Boecker, B. B.; McClellan, R. O. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

To provide an experimental evaluation of the adequacy of single acute inhalation data for predicting the retention kinetics associated with repeated exposures, 12 beagle dogs were given weekly, 10-min inhalations of an aerosol of ^{137}Cs-labeled fused clay particles. Whole-body counting and lung scanning to determine kinetics of buildup in the animal were performed before and after each exposure and periodically between exposures to provide data for comparison with single acute inhalation exposure studies. Average initial pulmonary deposition was ~19% of the total inhaled radioactivity. Average air concentration during each exposure was maintained at ~1.2 μCi/liter air. Accumulation in the pulmonary compartment as a function of the air concentration breathed during each weekly exposure has been at a linear rate. Retention patterns will be followed in selected dogs after 10, 20, or 40 weekly exposures, out to 3 years from the initial inhalation. Tissues from dogs sacrificed after 10 and 20 exposures indicated most of the ^{137}Cs to be associated with lung. (auth)

715 (LF-46, pp 295-300) PRELIMINARY REPORT ON THE EFFECTS OF REPEATED INHALATION EXPOSURE OF MICE TO $^{144}CeO_2$. Lundgren, D. L.; McClellan, R. O.; Hahn, F. F.; Sanchez, A.; Newton, G. J. Dec 1973.

In annual report of the Inhalation Toxicology Research Institute, October 1, 1972–September 30, 1973.

To provide information on the effects of repeated inhalation exposure to radioactive aerosols for comparison with available data on the effects of single acute inhalation exposure, mice were repeatedly exposed to $^{144}CeO_2$ to maintain lung burdens (LB) near 4.5, 1.0, and 0.2 μCi of ^{144}Ce and are being maintained for lifespan observation. Results are being compared with those from three groups of mice having similar initial LB (ILB) after a single exposure. Mortality increased slightly among the mice in the highest μCi level of the repeatedly exposed group compared with single exposed mice having similar ILB. Repeated inhalation exposure to $^{144}CeO_2$ reduced clearance of inhaled ^{144}Ce during the first seven days post-repeated exposures and increased retention of ^{144}Ce after 7 days. These effects were most evident in the mice with the highest LBs. (auth)

716 (RISO-294, pp 61-71) RETENTION OF THE DAUGHTERS OF THORIUM 232 IN THE SOFT TISSUE IN ANIMALS. Trolle, C. (Finsen Inst., Copenhagen). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Ten percent of ^{228}Ra injected intravenously was deposited in the bones in equilibrium with all of its daughters. No ^{228}Ra was found in the soft tissue. About 30 to 40% of ^{228}Ra injected in animals is deposited in the soft tissue. Of the daughters formed by ^{228}Th about 40% were found in the body of a sacrificed animal. Of this 40%, 15 to 20% arose from thoron, which diffused to the blood, but decayed before the blood arrived in the lungs. Of the 60% of the ^{228}Th daughters that left the living animal, about 15 to 20% was exhaled as ^{220}Rn, about 40% was excreted as ^{224}Ra, and about 5% was excreted as ^{212}Pb. In the evaluation of the radiation dose to a tissue in which Thorotrast is deposited it is necessary to know to what extent the thorium daughters will move away from the site where they have been formed. In order to get a clearer picture of the fate of the individual thorium daughters their behavior without the presence of the parent from which they will be continuously formed was studied. The interest was concentrated around the long-lived living nuclides, i.e., the radium isotopes 228 and 224, the thorium isotope 228, and the lead isotope 212. Apart from thoron, the radon isotope 220 is of interest, in spite of its short half life, as it is an inert gas that will rapidly diffuse to the blood and will be partly exhaled in the lungs. (auth)

717 (RISO-294, pp 72-80) DISTRIBUTION OF THOROTRAST AND ITS DAUGHTER NUCLIDES AND ESTIMATION OF ABSORBED DOSE IN THE HUMAN ORGANS. Okawara, S. (Nagoya Univ., Japan). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Thorotrast was intravenously injected into 80 SM mice. The volume administered per animal was 0.1 cc for one half of the samples and 0.5 cc for the remaining half. Twenty of the animals given 0.1 cc and an equal number of those given 0.5 cc were sacrified three months after injection, and the gamma activity in their organs was measured for the ensuing 30-day period under identical conditions for all samples. The rest of the samples were likewise sacrificed and examined five months after injection. The build-up curves, plotted for each organ on the basis of these measurements, indicated that 19.9% of injected ThO_2 had been excreted and that 86% of the ThO_2 retained in the body had deposited in the liver, spleen, and bone at the ratio of 67 : 22 : 11, respectively. The rate of thorium daughter excretion by these organs was measured at 76% for the liver, 79% for the spleen, and 130% for the bone. The absorbed dose of internal irradiation, estimated from the foregoing results, was much smaller than the values reported in the past. Incidentally, no significant difference of measurement results was noted between the animals given 0.1 cc of Thorotrast and those given 0.5 cc. (auth)

718 AUTORADIOGRAPHIC STUDIES ON THE DISTRIBUTION OF SOME METAL IONS IN THE ORGANS OF WISTAR RATS. A Contribution to Metal Excretion. Huebscher, J.; Presselt, N.; Halbhuber, K. J.; Geyer, G. (Friedrich-Schiller-Univ., Jena, Ger.). Z. Mikrosk.-Anat. Forsch.; 86: No. 4, 553-559(1972). (In German).

The uptake of ^{65}Zn, ^{203}Hg, and ^{210}Pb was studied autoradiographically in Paneth cells, exocrine cells of the pancreas, cells of the prostate gland, of islets of Langerhans, of bone marrow, of retina, of hippocampus, of mast cells, and in hair of the rat. Paneth cells, prostate gland, exocrine pancreas, islets of Langerhans, and hair bulbs were labelled with ^{65}Zn, ^{203}Hg, or ^{210}Pb respectively 3 to 4 hrs after intraperitoneal injection of the metal isotope. Brain, retina, and mast cells remained unlabelled. An excretory activity for heavy metals of Paneth cells, prostate gland, exocrine pancreas, and of hair is presumed. (auth)

719 ANIMAL STUDIES FOR THE ESTIMATE OF THE RADIATION DOSE FROM ^{192}Ir IN MAN. Glaubitt, D. (Freie Univ., Berlin); Schaefer, H.; Kaul, A.; Koeppe, P.; Roedler, H. D.; Haberland, U. pp 305-309 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971). (In German).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Handling of soluble iridium compounds containing ^{192}Ir has to consider the incorporation of this radioisotope. In order to calculate the absorbed dose in man, experiments with ^{192}Ir as $(NH_4)_2$ $[IrCl_6]$ were carried out in rats. The kinetics of the total body retention can be described by a sum of 2 exponential functions. 90% of the injected radioactivity is excreted with an effective half-life of 1,2 h, 10% with an effective half-life of 625 h. For the calculation of the effective half-lives of ^{192}Ir in the organs studied a simple exponential retention was assumed. The effective half-lives ranged between 400 h and 1000 h in the rat. On the basis of these results, the absorbed dose for man amounts to 145 mrad/100 μCi ^{192}Ir for the total body, and 115 mrad/100 μCi ^{192}Ir for the gonads. The critical organ for ^{192}Ir are the kidneys with an absorbed dose of 1700 mrad/100 μCi ^{192}Ir. (auth)

720 RETENTION OF THE RADIOACTIVE METAL IONS ^{57}Co, ^{65}Zn, AND ^{203}Hg BY RATS. Berner, W.; Roedler, H. D.; Kaul, A.; Haberland, U.; Koeppe, P. (Freie Univ., Berlin). pp 391-396 of Radiation Biophysics, Free Radicals. Vol. II. Broda, E. (ed.). Vienna; Wiener Medizinische Akademie (1971).

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Female Wistar rats were injected with $^{57}CoCl_2$, $^{65}ZnCl_2$, and $^{203}HgCl_2$ in order to study the kinetics of distribution and excretion influenced by a chelating agent (Dimethylcysteine; Penicillamine (PA); Metalcaptase). 200 μmol PA were supplied immediately after intravenous injection of the radionuclides. From measurements of whole-body retention and radioactivity of different organs between 5 minutes and about 650 hours of control- and PA-animals, both the distribution and the effective half-lives of the radionuclides injected were calculated by regression analyses. The results of the animal experiments were transferred to man. Assuming similar distribution factors and effective half-lives in man the dose reduction by PA was calculated and proved to be about 60% for ^{57}Co referred to the gonads, and 30% for ^{203}Hg and 20% for ^{65}Zn, respectively. (auth)

721 CONTINUOUS MONITORING OF ^{14}C ACTIVITY IN BLOOD. Page, B. F. J.; Baines, M. W. (Huntingdon Research Centre, Eng.). Int. J. Appl. Radiat. Isotop.; 25: No. 1, 45-46 (Jan 1974).

A flow cell designed specifically for the determination of low-energy β emitting radionuclides in the circulating blood of mammals was constructed from KL 211 polystyrene plastic scintillator. The U-shaped flow channel is formed in the plastic scintillator so that as large a contact area as possible exists between the blood and the scintillator for events to occur while still presenting the smallest possible area of blood in the field of view of the photomultiplier tubes. Calibration showed a counting efficiency of 1.5 to 3%. Alteration of blood flow-rate through individual flow cells produced no change in the measured ^{14}C over the range 0 to 100 Ml min^{-1}, as long as there was a constant level of ^{14}C in the blood passing through the cell. Blood flow through the flow cells was monitored routinely. A typical recorder trace obtained following the intravenous administration of a dose of ^{14}C-nicotine (40 to 60 μg kg^{-1}) to a baboon is shown on which the individual peaks in arterial blood can be clearly seen. The system described is capable of continuous monitoring of ^{14}C in circulating blood and should be applicable to a variety of other problems. (UK)

722 DISTRIBUTION AND EXCRETION OF URANIUM IN THE RATS, FOLLOWING THE INHALATION OF URANYL NITRATE AEROSOL. Okabayashi, H.; Nakagome, M.; Suzuki, M.; Watanabe, S.; Hongo, S. (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri; 8: No. 2, 73-78(Jun 1973). (In Japanese).

Distribution in the body and excretion patterns of uranium were investigated, following the inhalation of uranyl nitrate aerosols (concentration of uranium were 4.2 μg/l and 26.4 μg/l respectively) by adult rats. Amounts of uranium in the lung and the kidney immediately after the inhalation of the aerosol were about ten to several tens times greater than those in other organs, but decreased to the level of background after about one month. Following the single inhalation of the aerosol, the levels of uranium in liver, spleen, blood, and bones were almost in background level during the period of one month thereafter. However, as the amount of uranium in the liver almost coincided with that of the spleen, it is estimated that the dose delivered to the spleen is more than ten times that of the liver, in comparison of both weights. The excretion of uranium in urine increases, according to the inhalation of uranyl nitrate. Therefore, uranium in urine is considered as a good index of the body burden of uranium for the estimation in case of the inhalation of the uranyl compound. (auth)

723 INTERPRETATION PROBLEMS OF INTESTINAL IRON ABSORPTION FROM ISOTOPICALLY LABELLED MEAT. Pfau, A. (Max-Planck-Institut fuer Tierzucht und Tierernaehrung, Mariensee). Experientia; 30: No. 1, 43-44(15 Jan 1974).

Edible portions of pork, obtained from in vivo ^{59}Fe-labeled pigs, were homogenized with phosphate buffer and after centrifugation the supernates were fractionated by chromatography on a Sephadex G 100 column. Different $^{59}Fe/Fe$ values in the iron-containing fractions were obtained so that the measurable ^{59}Fe retention is not directly related to the resorbed iron content of the meat. (HLW)

724 UPTAKE OF IODINATED HUMAN CHORIONIC GONADOTROPIN BY MONKEY OVARIES IN VIVO. Kammerman, S.; Channing, C. P. (New York Univ., NY). J. Clin. Endocrinol. Metab.; 38: No. 3, 463-467(Mar 1974).

Radioiodinated human chorionic gonadotropin (^{125}I-hCG) was administered intravenously to sexually mature female rhesus monkeys. One hr following injection, the specific radioactivity of intact ovaries, ovarian substructures separated by dissection, and various other tissues, including blood, was measured. Intact ovaries containing a corpus luteum, as determined by both morphology and in vivo progestin measurements, had significant ability to concentrate radioactivity relative to blood and other tissues. Although corpora albicania and luteal cysts also concentrated radioactivity, corpora lutea had the greatest uptake of ^{125}I-hCG, concentrating radioactivity approximately 30 times over non-luteinized tissue of the contralateral ovary. Unlabeled hCG injected along with the ^{125}I-hCG inhibited both whole ovary and corpus luteum uptake of radioactivity. In contrast, ^{125}I-albumin was not specifically concentrated by either the intact ovary or the ovarian substructures. Differences in the comparative ability to concentrate ^{125}I-hCG of the various structures of these primate ovaries may be a reflection of their relative number of gonadotropin receptor sites. (auth)

Plants

Refer also to abstracts 306 and 311.

Microorganisms

725 NATURAL CONTAMINATION LEVELS REACHED BY ALGAE DUE TO ALPHA EMITTERS IN THE CENTRAL VALLEY OF THE TAJO RIVER. Alvarez Ramis, C. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 17: No. 84, 303-308 (1973). (In Spanish).

Species of the Manzanares, Guadarrama, Tajuña, and Tajo Rivers (from the Bolarque swamp to the vicinity of Toledo) were studied for their contamination levels. The data obtained between 1958 and 1971 are tabulated. (tr-auth)

New Tracer Techniques

Refer also to abstracts 26, 82, 334, 352, 690, 695, and 2220.

726 (AAEC/E-303) USE OF A RADIOACTIVE TRACER TO STUDY THE NESTING SYSTEM OF MASTOTERMES DARWINIENSIS FROGGAT. Spragg, W. T.; Fox, R. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1974. 10p. Dep. NTIS (US Sales Only) $4.00.

A new method for the tracing of termite nesting systems is proposed and proved in field trials with Mastotermes darwiniensis nesting systems. An attractive bait containing γ emitting scandium-46 oxide is inserted into an infested site. The bait is eaten rapidly and taken to the nests where trophallactic transfer spreads the scandium through the colony members. The scandium is finally excreted and the excreta fixed in the gallery walls and carton of all subcentres which can then be found using a γ detector. The use of other radionuclides as colloids in similar bait is described. This method appears to introduce a new concept into the tracing of social insects. (auth)

727 (COO-3424-1) PROGRAM FOR THE STUDY OF TRANSPLANTATION OF TISSUES AND ORGANS AND RELATED TOPICS IN SURGICAL RESEARCH. Final Technical Report, January 1, 1973. Moore, F. D. (Peter Bent Brigham Hospital, Boston, Mass. (USA)). 1 Jan 1974. Contract AT(11-1)-3424. 34p. Dep. NTIS $4.75.

Research activities in the following four general areas are reported: body composition as measured by isotope dilution; metabolism and endocrinology in surgical care in critical illness; post-traumatic pulmonary insufficiency; and transplantation of tissues and organs. (ERB)

728 (INIS-mf-1024) RELIABILITY OF A RADIOIMMUNOASSAY METHOD IN THE ESTIMATION OF GROWTH HORMONE IN HUMAN PLASMA. Higa, O. Z. (Sao Paulo Univ. (Brazil)). 1972. 68p. (In Portuguese). INIS. Thesis.

The several steps for the radioimmunoassay of human growth hormone (HGH) in the plasma were standardized: labelling of HGH standard with ^{125}I; purification of the labelled hormone by starch gel electrophoresis and Sephadex G-75 column; immunoreactivity test of the labelled preparation (incubation with the specific antibody); and separation of the free hormone (F) from the antibody bound hormone (B). It was shown that activated charcoal coated with human plasma is a reliable and simple agent for the separation of F and B. Statistical analysis indicated that the method has specificity, excellent precision, and accuracy allowing clear discrimination between HGH concentrations in the low and high ranges. (INIS)

729 (INIS-mf-1025) STANDARDIZATION OF RADIOIMMUNOASSAY TECHNIQUE IN THE DETERMINATION OF HUMAN PLASMA INSULIN. de Toledo e Souza, I. T. (Sao Paulo Univ. (Brazil)). 1972. 51p. (In Portuguese). INIS. Thesis.

The following steps were employed for the radioimmunoassay of insulin in human plasma: labelling of procine insulin with ^{125}I; purification of the labelled insulin through cellulose adsorption chromatography or starch gel electrophoresis followed by molecular exclusion column (Sephadex G-50 fine); immunoreactivity test of the labelled insulin and antibody binding; and separation of free hormone (F) from the antibody-bound (B) by the use of activated-charcoal coated with plasma. B/F ratios plotted against the correspondent insulin standard concentrations allowed us to obtain a standard-curve where the unknown plasma insulin concentrations (uU/ml) were obtained. The operational characteristics of the method were evaluated through accuracy, specificity, and precision, allowing us to measure plasma insulin levels in basal and after stimulation at the whole range of pancreatic pathology. (INIS)

730 (RISO-294, pp 259-266) HISTORADIOGRAPHIES AND AUTORADIOGRAPHIES FROM PIECES OF ORGANS OF PEOPLE INJECTED SYSTEMICALLY WITH THOROTRAST. da Silva Horta, J.; Moura Nunes, J. (Univ. of Lisbon). Jun 1973.

From proceedings of the 3rd international meeting on the toxicity of thorotrast; Copenhagen, Denmark (25 Apr 1973).

Autoradiographies were done in organs from people injected systemically with Thorotrast. The great amount of α tracks found in the liver and the spleen in comparison with the amount existing in other organs, explains why it is in these organs, especially the liver, that the greatest number of neoplasias appear. Historadiography proved to be a good method for detection of thorium dioxide in the organs. (auth)

731 (UCD-472-119, pp 95-96) DYNAMIC SCANNING STUDIES ON CANINE OSTEOSARCOMAS. Goldman, M.; Pharr, J. W.; Dixon, A. C.; O'Brien, T. R. Jun 1972.

In annual report, fiscal year 1972.

Visualization of ^{226}Ra-induced bone sarcomas by ^{18}F scanning provides a rapid means of diagnosis in beagles. Dynamic uptake patterns of ^{18}F in lesions progress about ten times more slowly than in normal bone and thereby afford a unique means of tumor staging. (auth)

732 (UCD-472-119, pp 97-100) APPLICATION OF A NEW BONE SCANNING RADIOPHARMACEUTICAL IN THE STUDY OF BONE TUMORS. Goldman, M.; O'Brien, T. R.; McRae, J.; Yano, Y.; Waterman, D.; Pharr, J. W. Jun 1972.

In annual report, fiscal year 1972.

Technetium-99m labeled stannous-ethane-1-hydroxy-1,1-diphosphonate (^{99m}Tc-EHDP) has a high bone specificity and provides certain advantages over conventional radiopharmaceuticals for scanning and dynamic studies of bone tumors. Results of scintiscanning for the localization of bone tumors in beagles and collies are reported. (CH)

733 (UCD-472-119, pp 124-127) MICROSCANNING MEASUREMENT OF $^{90}Sr-^{90}Y$ DISTRIBUTION IN BEAGLE HUMERI. Momeni, M. H.; Schwind, J. A.; Hinz, E. A. Jun 1972.

In annual report, fiscal year 1972.

A method for measuring the microdistribution of $^{90}Sr-^{90}Y$ in labeled bone is presented. The system, a microscanner, can be programmed for a fixed count measured by the detector, preselected scan rate and size; or a fixed integration period and a continuous motion. A preliminary measurement of $^{90}Sr-^{90}Y$ beta radiation emission distribution and the corresponding relative dose rates in a humeral section of a beagle are presented. (auth)

734 NEW RADIOISOTOPE SCANNING METHOD UTILIZING SELENOMETHIONINE FOR THE DIAGNOSIS OF PRIMARY HEPATOMA. Minier, J.; Joubaud, F.; Ben Bouali, A.; Pithon, G.; Cheguillaume, J. (Centre de Lutte Contre le Cancer Paul-Papin, Angers, France). J. Radiol., Electrol., Med. Nucl.; 54: No. 11, 831-834(Nov 1973). (In French).

The difference between the uptake of selenomethionine and colloidal technetium sulfide enables a primary liver tumor (fixing of selenomethionine and not the colloid) to be distinguished from a secondary tumor (fixing of neither product). Positive results were obtained in 6 out of 7 cases of primary hepatoma, the negative case being an undifferentiated tumor. In the case of the metastases, 2 false positives out of 7 (one carcinoma of the colon and one of the thyroid) occurred. The results obtained are particularly discriminating in comparison with other bloodless methods. (FR)

735 UTILIZATION OF ^{99m}Tc LABELED SODIUM PYROPHOSPHATE IN THE STUDY OF MALIGNANT BONE TUMORS. Ducassou, P.; Pigneux, J.; Parret, O.; Le Treut, A. (Hopital Saint-Andre, Bordeaux). J. Radiol., Electrol., Med. Nucl.; 54: No. 11, 823-830(Nov 1973). (In French).

The use of ^{99m}Tc as a tracer element is discussed and its physical characteristics given. The bone uptake of ^{99m}Tc-sodium pyrophosphate was studied. Explorations were carried out on 43 patients (10 normal and 33 with malignant tumors) using a scintillation camera. Scanning revealed increased uptakes by primary or secondary bone neoplasms in every case where they could be detected radiologically. Areas of pathological uptake were observed using scanning techniques for some cases in which radiography provided doubtful or negative results. A combination of tomography and scintiscanning was used to study problems that were difficult to interpret. The degree of uptake appears to be related with local osteogenic reactions. Technetium pyrophosphate appears to meet routine examination requirements, in particular in the case of infraradiological bone metastases. (FR)

736 FURTHER INVESTIGATIONS INTO A METHOD OF BACKGROUND SUBTRACTION IN THE SIMULTANEOUS USE OF ^{59}Fe AND ^{51}Cr IN A SCATTERING MEDIUM. Johnston, A. R.; Earnshaw, J. C.; Granley, K.; Bell, T. M. (Queen's Univ., Belfast). Phys. Med. Biol.; 19: No. 1, 105-106(Jan 1974).

In the simultaneous use of two radioisotopes in in vivo, discrimination of the count rates from the two isotopes is carried out by using a NaI(Tl) detector and single channel analyzers to select a total absorption peak for each of the radioisotopes. Due to Compton scattering, higher energy gamma rays contribute to the background in the lower energy channel. A three-gate method for background subtraction was suggested by Bell et al (Bell, T. K., Johnston, A. R. and Spiers, E. W., 1970. Phys. Med. Biol. 15, 475) but was criticized in that all sources were placed on the axis of the cylindrical collimator. Off-axis investigations were made to establish the sensitivity of the method to the mean source position in the scattering position. It was found that in measurements of ^{51}Cr the method of monitoring the background due to the presence of ^{59}Fe was acceptable to within a 6% error. (UK)

737 CEREBRAL ANGIOGRAPHY BY ^{99m}Tc, $^{131}IMAA$, AND ^{133}Xe. Kvicala, V.; Pospisilova, A.; Ulrychova, J. Cas. Lek. Cesk.; 112: 1169-1173(21 Sep 1973). (In Czech).

Comparison was made of results of three methods: radiopertechnate intravenous angioscintigraphy, scintigraphy after intracarotic administration of macroagregate of ^{131}I-serumalbumine and quantitative determination of the blood flow after ^{133}Xe administration. The examination was carried out in 50 patients always by at least two methods. In the radioxenon method clinical utilization is limited and suited chiefly for study of the pathophysiology of cerebral flow. Angioscintigraphy by ^{99m}Tc is simple and can be regarded as a refinement of cerebral scintigraphy. Scintigraphy after intracarotic administration of the macroaggregates represents enrichment of the diagnostic of the brain lesions. (auth)

738 TECHNIQUES FOR MEASURING CELL VOLUMES AND PLASMA VOLUMES. Belcher, E. H. (International Atomic Energy Agency, Vienna); Berlin, N. I.; Eernisse, J. G.; Garby, L.; Glass, H. I.; Heimpel, H.; Lee, M.; Levis, S. M.; MacIntyre, P.; Mollisson, P. L.; Murphy, E. A.; Najean, Y.; Suzur, L. J. Biol. Med. Nucl.; 8: No. 33, 28-36(1973). (In French).

Technical problems encountered in blood volume measurements are discussed: measurement of cell volumes using either radioactive chromate and washed cells, or ^{51}Cr and ascorbic acid, or ^{32}P labeling; measurement of plasma volumes using radioiodated serum-albumin. The use of automatic blood volume measurement equipment is not recommended as the few advantages which it brings out outweighed by disadvantages, current techniques in this domain not being sufficiently developed. The problem of the residual radioactivity present in the blood after repeated blood volume measurements is discussed. It is recalled that the calculation of the total blood volume necessitates the use of two different tracers which can be measured independently of one another. The combination of ^{125}I-labeled albumin and ^{51}Cr-labeled red cells is almost ideal from this point of view. A table is given of the irradiation doses received after cell volume and plasma volume measurements. (FR)

739 RADIOIMMUNOASSAY OF ALDOSTERONE IN PLASMA AND URINE: VALIDATION OF A NOVEL SEPARATION TECHNIQUE AND A RAPID URINE ASSAY. Jowett, T. P.; Slater, J. D. H.; Piyasena, R. D.; Ekins, R. P. (Middlesex Hospital, London). Clin. Sci. Mol. Med.; 45: No. 5, 607-623(Nov 1973).

A rapid, robust, accurate, and sensitive radioimmunoassay procedure is described for the measurement of plasma and urinary aldosterone. A new, simple method is validated for the separation of free from bound moieties that has general applicability and involves the measurement of free steroid by direct extraction into toluene-based liquid scintillator. A new method, of validated

specificity, is described for the measurement of the acid-labile metabolite of aldosterone in urine which avoids the necessity for preliminary chromatographic purifications. [1,2-^{3}H] 17β-aldosterone was used as the labelled compound. (auth)

740 RADIOIMMUNOASSAY FOR DEOXYCORTICOSTERONE IN HUMAN PERIPHERAL PLASMA USING SEPHADEX LH-20 CHROMATOGRAPHY. Casto, A.; Chung, A.; Jelen, B.; Kutas, M. (United Medical Labs., Portland, OR). Experientia; 29: No. 12, 1581-1582(Dec 1973).

Extracts of ^{3}H-deoxycorticosterone were prepared and techniques are described for radioimmunoassay using Sephadex LH-20 chromatography. Normal levels of the hormone were determined by assaying 12 normal subjects. Comparative studies with three methods (protein binding, isotope dilution, and radioimmunoassay) showed that similar values were obtained with all techniques thus indicating the accuracy of the new method. (HLW)

741 RADIONUCLIDES IN HEMATOLOGICAL DIAGNOSTICS. Ciresa, M. (Univ., Innsbruck, Austria). Fortschr. Med.; 91: No. 18, 783-786(1973). (In German).

The diagnostic value of radioisotope tracer studies in hematology are discussed. The results of Schilling tests, erythrocyte survival determinations using ^{51}Cr, in relation to the erythrocyte type, and ferrokinetic studies using ^{59}Fe plasma clearance are discussed. (tr-auth)

742 SICKLE HEMOGLOBIN: A SPECIFIC RADIOIMMUNOASSAY. Rowley, P. T.; Doherty, R. A.; Rosecrons, C.; Cernichiari, E. (Univ. of Rochester, NY). Blood; 43: No. 4, 607-611 (Apr 1974).

For the quantitation of hemoglobin S, a radioimmunoassay was developed that is specific and highly sensitive. Hemoglobin S was purified by column chromatography and injected with complete Freund's adjuvant into goats. Each goat serum was tested for reactivity against hemoglobins A and S by immunodiffusion and by quantitative precipitation. Hemoglobin A reactivity was removed by absorption with hemoglobin A. One serum so treated was specific for hemoglobin S; it reacted negligibly with hemoglobins A or F. Hemoglobin S was labeled with ^{125}I by the chloramine T method. In the radioimmunoassay, complete precipitation of the antigen–antibody complex was insured by the addition of rabbit antigoat gamma globulin. This assay offers reliable and specific quantitation of as little as 1 ng of hemoglobin S. Assuming that 10% of the hemoglobin in fetal blood at 16 wk gestation is of adult type, this assay is capable of detecting the amount of hemoglobin S in 10^{-7} ml of homozygous hemoglobin S blood. The prenatal diagnosis of sickle cell anemia by radioimmunoassay will require, in addition, a method for demonstrating the absence of hemoglobin A and a safe method for obtaining fetal erythrocytes without significant contamination by maternal erythrocytes. (auth)

743 TRIAL OF RADIOLABELED ANTIBODY LOCALIZATION IN METASTASES OF A PATIENT WITH A TUMOR CONTAINING CARCINOEMBRYONIC ANTIGEN. Reif, A. E.; Curtis, L. E.; Duffield, R.; Shauffer, I. A. (Boston Hospital). Contract AT(11-1)-3012. J. Surg. Oncol.; 6: No. 2, 133-150(1974).

An attempt to detect metastatic cancer by the specific localization of radiolabeled antibody is reported. The patient had far advanced carcinoma of the colon and a high level of carcinoembryonic antigen (CEA) in serum. She was given whole unabsorbed rabbit antiserum to CEA intravenously, to determine whether CEA can be removed from the circulation. A transient partial depression of the CEA level in serum was obtained, followed by a rebound. Absorbed and purified antibody radiolabeled with ^{131}I was injected intravenously 19 days later. Total body scans showed no evidence of the localization of the radiolabel in cancer tissue. After another 5 days, injection of the same radiolabeled antibody solution directly into the hepatic artery was attempted. Again, no evidence of localization in liver metastases was obtained. All three infusions of antibody to CEA caused reactions that were ameliorated by Benadryl. Future trials may have better success if monospecific anti-CEA is used and patients are chosen who have CEA-producing tumors, but whose serum CEA levels are low or negative. (auth)

744 RADIOIMMUNOASSAY FOR THE DIRECT MEASUREMENT OF RENIN IN MICE AND ITS APPLICATION TO SUBMAXILLARY GLAND AND KIDNEY STUDIES. Michelakis, A. M.; Yoshida, H.; Menzie, J.; Murakami, K.; Inagami, T. (Vanderbilt Univ., Nashville). Endocrinology; 94: No. 4, 1101-1105(Apr 1974).

A radioimmunoassay for the direct measurement of renin has been developed using antibodies raised against purified mouse submaxillary renin. This method was employed to measure renin in mouse plasma, submaxillary glands and saliva under various experimental conditions. Renin values obtained by this immunoassay procedure correlate closely to those observed by bioassay. The concentration of radioimmunoassayable submaxillary gland renin in mice is androgen dependent. This method provides a direct, rapid, and highly sensitive measurement of renin and thus could be used in further physiologic studies on the kidneys and submaxillary glands. (auth)

745 SOLID PHASE RADIOIMMUNOASSAY FOR THE DIAGNOSIS OF HUMAN HYDATIDOSIS. Musiani, P.; Piantelli, M.; Arru, E.; Pozzuoli, R. (Univ. Cattolica del Sacro Cuore, Rome). J. Immunol.; 112: No. 5, 1674-1679(May 1974).

Application of solid phase radioimmunoassay in the diagnosis of human hydatidosis is reported. Using plastic tubes or plastic cups coated with pure Echinococcus antigens (EA) and incubating with ^{125}I-radioiodinated human anti-EA IgG and appropriate amounts of hydatidosis sera, a competitive inhibition of the ^{125}I anti-EA-binding reaction was demonstrated. The sensitivity and the specificity of this test were compared with the radioimmunoelectrophoretic, passive hemagglutination, and radioimmunoprecipitation tests. The solid-state competitive binding radioassay offers clear advantages as regards the other tests so far utilized. Sensitivity as well as specificity is very high so that this method can be considered the test of choice in the serologic diagnosis of human hydatidosis. (auth)

746 USE OF ^{125}I AS A MEMBRANE PROTEIN LABEL FOR ERYTHROCYTE SURVIVAL STUDIES. Weintraub, M.; Gerson, K.; Silber, R. (New York Univ., Medical Center, NY). Blood; 43: No. 4, 549-556(Apr 1974).

Radioactive iodide, incubated with erythrocytes in the presence of lactoperoxidase and hydrogen peroxide, is covalently bound to membrane proteins. Using this technique, rabbit erythrocytes were labeled with ^{125}I, reinjected into the donors, and erythrocyte survivals determined. The values for the erythrocyte half-lives and the shape of the decay curves were comparable to those reported using DF^{32}P. Following hemolysis of erythrocytes double labeled with ^{125}I and ^{51}Cr, radioactivity from both these isotopes appeared mainly in liver, lung, kidney, spleen, and urine. Enzymatic iodination provides a nonleluting label of erythrocyte membrane proteins for the study of survival, sequestration, and turnover of this red cell component. (auth)

747 VARIOUS RADIONUCLIDE PATTERNS OF CEREBRAL INFLAMMATION IN INFANTS AND CHILDREN. Gilday, D. L. (Univ. of Toronto). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 120: No. 2, 247-253(Feb 1974).

From 74th annual meeting of the American Roentgen Ray Society; Montreal, Can. (23 Sep 1973).

Radionuclide scanning is a valuable screening procedure in patients with cranio-cerebral inflammations. The patterns found in diffuse encephalitis are sufficiently specific to separate them from focal encephalitis or abscess. The appearance of the lateral ventricles on the brain scan is specific for ventricular inflammation. To aid in the differentiation between vault and intracranial inflammations the bone scan is of considerable value, as it is abnormal with vault lesions but not for those within it. (auth)

748 DOUBLE-ANTIBODY RADIOIMMUNOASSAY FOR B16 MELANOMA ANTIBODIES. Bystryn, J. C. (New York Univ., NY); Schenkein, I.; Uhr, J. W. J. Nat. Cancer Inst.; 52: No. 3, 911-915(Mar 1974).

A double-antibody radioimmunoassay was developed that quantitated the antibody response to melanoma-associated antigens (MAA). The assay was based on the coprecipitation by anti-immunoglobulin of complexes of radiolabeled MAA with tumor antibodies. MAA were radiolabeled by incubation of melanoma cells in tissue culture with ^{3}H-leucine. Serum of C57BL/6J mice, immunized by repeated injections of irradiated B16 melanoma cells, bound 4–8 times as much radiolabeled MAA as did serum of normal mice. The relationship was linear between the amount of MAA bound and the amount of antiserum used. The assay was sufficiently sensitive and reproducible to measure changes in the levels of antibodies to B16 melanoma during its natural growth. Antibody levels declined during the late phase of tumor growth. There were cross-reactions between the serum of mice immunized to mammary adenocarcinoma and MAA and between anti-melanoma serum and antigens in syngeneic fibroblasts, which suggests the presence of shared antigenic determinants between these tumors and normal mouse tissue. (auth)

749 RADIOIMMUNOASSAY OF IMMUNE GLOBULIN. From the Function of Immune Globulin to the Structure. Watanabe, S. (Osaka Univ.). Sogo Rinsho; 22: No. 8, 1580-1588(Aug 1973). (In Japanese).

Various methods of radioimmunoassay of immune globulin (Ig) are given. Specific antiserum obtained from purified myeloma protein is used in measurement of each class of Ig. There are external and internal labeling methods in radioisotope labeling

method of Ig or its fragments. In the former method, ^{131}I, ^{125}I, ^{130}I, and ^{35}S are used. In the latter method called biosynthetic labeling, Ig is labeled by taking radioactive amino acids or sugar (^{14}C or ^{3}H) into Ig in vitro and in vivo. As assay by precipitation reaction, (1) direct precipitation method, (2) competitive precipitation method, and (3) method by precipitation reaction in gel were mentioned. Method (1) is used in determination of Ig labeled by internal labeling method or its intermediate Ig and Ig fragments. Method (2) is a determinative method used in clinical examinations. Result of discussion on bond capacity of three kinds of rabbit IgM serum was illustrated. Method (3) is to raise accuracy and sensitivity by autoradiogram in using labeled Ig or anti-Ig antibodies. This method needs a fair amount of specific anti-serum and Ig or its fragments of a known quantity as standard. Assay using immunoadsorbent method in purification of antibodies makes anti-Ig antibodies or antibody Ig insoluble, measures bond capacity with immunoadsorbent, and measures Ig from bond amount of labeled Ig or its fragments or anti-Ig antibodies. This method does not form precipitates and is able to determine minute amount of Ig. Substances of which particles are small and are difficult to precipitate such as intermediate fragment of Ig can be measured easily by the method using insoluble particulate immunoadsorbent. Applied examples of method using solid phase immunoadsorbent were mentioned. (JA)

750 QUANTITATIVE EVALUATION OF HEMISPHERIC CEREBRAL BLOOD FLOW BY INHALED ^{133}Xe AND SCINTILLATION CAMERA. Aoyama, T.; Yamauchi, Y.; Nukada, T. (Osaka Univ.). No To Shinkei; 25: No. 12, 1555-1560(Dec 1973). (In Japanese).

In this work, CBF measurement by the inhalation method of ^{133}Xe using a scintillation camera combined with an on-line minicomputer was evaluated. The patient lay in the supine position and the detector of the scintillation camera was placed closely on the frontal plane from anterior 30° axial position. After 10 mCi of ^{133}Xe was inhaled by means of the closed circuit system for 2 minutes, room air was inspired with non-rebreathing valve. Simultaneously the radioactive clearance curve from the head was measured for 40 min. The serial R. I. data were transfered to the magnetic tape through the computer having 8K words memory according to the afore-settled sampling time. After the examination of ^{133}Xe inhalation method the brain scintigram of ^{99m}Tc administered intravenously was taken in order to determine the area of interest (AOI). The ^{133}Xe clearance curve from the AOI was analyzed by the method of three compartment analysis which provided the separated blood flows for gray matter, white matter, and a slow third component. The third component was presumably due to extracranial tissue. Hemispheric cerebral blood flow (H-CBF) was measured on six patients with cerebrovascular disease, two patients with aortic arch syndrome, and a mild hypertensive. In these patients, no significant differences were obtained between each H-CBF value except one case. A patient with the significant low value of the left H-CBF was induced dizziness and syncope by compression of the left carotid artery. The left posterior cerebral artery and communicating artery were demonstrated by the right carotid angiogram. In an aortic arch syndrome patient with remarkable narrowing of left carotid and vertebral arteries and markedly developed collateral vessels, left H-CBF value did not decrease. Both arm to retina circulation time using fluolescein and brain mean transit time by ^{99m}Tc showed no significant differences between each hemisphere corresponding to that of H-CBF values. (auth)

751 NON-SPECIFIC INHIBITION OF SERUM FOR BOUND PERCENT IN DOUBLE ANTIBODY RADIOIMMUNOASSAY. Yoshimura, M.; Ochi, Y.; Hachiya, T.; Shiomi, K.; Miyazaki, T. (Kyoto Prefectural Univ. of Medicine). Kaku Igaku; 10: No. 5, 451-456(Oct 1973). (In Japanese).

The effect of various human serums on the standard curve of HGH and HTSH RIA was analyzed using pooled human serum as normal human serum (NHS), serum from the patient of panhypopituitarism (PPS) and the serum removed its hormone by dextran-coated charcoal (DCC) solution (20% charcoal and 2% dextran in saline). In figuring the standard curve of HGH and HTSH RIA, the bound percent (B%) of the standard curve using 0.5% BSA buffer solution (for HGH) or 1% BSA buffer solution (for HTSH) was higher than the B% of assay system containing with PPS, PPS treated with DCC, NHS and NHS treated with DCC. The above finding indicated that some factor to inhibit B% nonspecifically existed in serum, that the inhibiting factor of B% could not be removed by DCC, and that the hormone free serum (HFS) is necessary for figuring the standard curve of RIA. In analyzing the factor to inhibit B% in serum, the standard curves of HTSH with NHS or with NHS removed the complement by heat treatment with 56°C for 30 min was figured identically and it was found that complement did not act on inhibiting factor for B%. Regarding the amount of first antibody (antiserum for HGH or HTSH) and of second antibody (anti-rabbit γ globulin goat serum), different amounts of antibody, such as first antibody rich or second antibody rich, were given the three different assay system of serum free system, serum 0.1 ml and serum 0.3 ml using NHS, PPS, and NHS treated with DCC. In this study it was found that B% in system containing serum was lower than that without serum. The B% in serum 0.3 ml was much lower than that in serum 0.1 ml. By applying larger amount of 2nd antibody than the amount of instruction manual, it is possible to prohibit the decrease of B% inducing by serum 0.1 ml. However it is impossible to prohibit the decrease of B% in serum 0.3 ml. On the contrary, the amount of 1st antibody is also important to prohibit the decrease of B% in serum and both antibodies in optimal amounts are necessary to get the better result. From these results, it is very important to use hormone free serum as diluent for double antibody RIA. (auth)

752 CLINICAL PRACTICE USING RADIOACTIVE ISOTOPES (RI). XI. Scanning of Tumor by High-Sensitivity Collimator for ^{67}Ga. Asahara, A. (Central Hospital of JNR, Tokyo). Kotsu Igaku; 25: No. 2, 131-140(Mar 1973). (In Japanese).

The general properties and efficiency of collimators are described. Using the ^{67}Ga ray source, comparison was carried out between the preexisting LK-15-20A collimator and LK-15-12.5 collimator for which sensitivity was increased by expanding the pore surface and shortening the focus. The theoretical sensitivity of LK-15-12.5 was 3.32 times higher than that of LK-15-20A, and the radius of the visual field of the former was about 50% larger. The conditions of the maximum sensitivity for isosensitive scanning using LK-15-20A were obtained by single, 5% analyze method by LK-15-12.5. In view of resolving power, off the focus LK-15-12.5 produces extremely large widths of half value, but it was possible to increase the rate down to ½ to ¼ and the cutoff to 20 to 30% in accordance with an increase in sensitivity depending on the conditions for shooting, compared with LK-15-20A. Presented were the scintigrams of a case of sarcoidosis, two cases of primary pulmonary cancer (including adenocarcinoma), and a case of metastasis of parotid adenocarcinoma, using LK-15-20A. LK-15-12.5 showed positive results in 50 (86.2%) of the 58 cases examined and 36 of 40 cases of pulmonary cancer (90%). It was not possible that 100% of ^{67}Ga-citrate itself was incorporated into malignant tumor, having almost reached the limits of the ^{67}Ga method. This new instrument is evidently better than the pre-existing ones in the shape of each positive focus and minute findings in the focus, enabling the detection of intramediastinal metastatic foci and tumor in the region hidden by the heart shadow, which was difficult to diagnose radiologically. Satisfactory results were not necessarily expected in the case of negative findings. In the experiment using a liver phantom, the detectable limit of small foci was low. (JA)

753 $^{99m}Tc_2S_7$ COLLOID LIVER SCINTIGRAPHY FOR THE EVALUATION OF DIFFUSE HEPATIC DISEASE. Aburano, T.; Suzuki, Y.; Hisada, K. (Kanazawa Univ., Japan). Kaku Igaku; 10: No. 6, 549-553(Dec 1973). (In Japanese).

$^{99m}Tc_2S_7$-colloid liver scintigraphy for the evaluation of diffuse hepatic disease has been considered to be questionable because of very frequent visualization of the spleen in most of normal cases whereas no visualization of the spleen is noticed in ^{198}Au-colloid liver scintigraphy. Therefore, the comparison of extrahepatic distribution was done on anterior liver scan between $^{99m}Tc_2S_7$-colloid and ^{198}Au-colloid, and the following results were obtained. Degree of splenic activity: Twenty-three of 24 cases where splenic activity exceeded that of liver with $^{99m}Tc_2S_7$-colloid showed various degrees of splenic activity with ^{198}Au-colloid. Conversely, twenty-six of 32 cases where liver activity exceeded that of spleen including no splenic visualization with $^{99m}Tc_2S_7$-colloid did not show any splenic visualization with ^{198}Au-colloid. Therefore, in the case where splenic activity exceeded that of liver on $^{99m}Tc_2S_7$-colloid anterior liver scan, the splenic activity is considered to be significantly abnormal. Another extrahepatic activity was bone marrow and lung. Bone marrow activity with $^{99m}Tc_2S_7$-colloid were obtained in 10 cases, and nine of which were cirrhosis. Lung activity was observed most frequently in cirrhosis, i.e., 85% of cirrhosis. On the other hand, it was observed less frequently in other diseases, i.e., 13 to 24%. This result suggests the possibility that the pulmonary reticuloendothelical activity rather than embolization of macroaggregates is participated in lung activity. From these results, $^{99m}Tc_2S_7$-colloid is considered to be fully applicable radionuclide of anterior liver scintigraphy for the evaluation of diffuse hepatic disease, and specific findings in cirrhosis are considered as follows, splenic activity highly exceeded that of liver, bone marrow activity and/or obvious lung activity on $^{99m}Tc_2S_7$-colloid anterior liver scan. (auth)

754 MEASUREMENT OF PLASMA RENIN ACTIVITY BY ANGIOTENSIN I RADIOIMMUNOASSAY. Ogihara, T. (Osaka Univ.); Kumahara, Y.; Yamamoto, T.; Doi, K.; Omori, K. Kaku Igaku; 10: No. 6, 555-563(Dec 1973). (In Japanese).

Plasma Renin Activity (PRA) by radioimmunoassay (RIA) of angiotensin I using commercial (PRA) kit was evaluated, which was provided by Dainabot Isotope Laboratory. The effects of variations in incubation time, kinds and amount of angiotensinases and/or converting enzyme inhibitors, and optimal pH during incubation were tested. One particular problem with this assay, non-specific effect of deproteinized supernatant of angiotensin free serum was found. Some data obtained with normal subjects on normal salt restriction and forced salt intake were enclosed. (auth)

755 USE OF RADIOISOTOPE AND POLYCARDIOGRAPHIC TECHNIQUES FOR EVALUATION OF HEMODYNAMICS IN PATIENTS WITH AORTIC VALVE DISEASES. Pracka, H.; Krzeminska-Pakula, M.; Tracz, W.; Surma, M.; Kaluzna, J. (Inst. of Internal Medicine, Lodz, Poland). Pol. Tyg. Lek.; 27: No. 1, 4-6(1972). (In Polish).

In 68 patients with aortic valve diseases the dynamics of left ventricular contraction were studied. In 21 patients radiocardiographic investigations were carried out. An attempt was made to assess what changes develop in the individual parameters of the polycardiogram and radiocardiogram depending on the haemodynamic effects of the disease and the efficiency of the circulatory system. One single determination of the dynamics of left ventricular contraction was not sufficient to assess the efficiency of the circulatory system in these patients. On the other hand, the analysis of the time of half decay of radioactivity in the left heart was very useful for assessment of the efficiency of circulation. (auth)

756 TOTAL EXCHANGEABLE POTASSIUM IN HYPERTHYROIDISM AND HYPOTHYRODISM (INVESTIGATIONS WITH RADIOACTIVE POTASSIUM ^{42}K AND RADIOACTIVE RUBIDIUM ^{86}Rb). Gembicki, M.; An, P. S. (Medical Academy, Poznan, Poland). Endokrynol. Pol.; 23: 453-460(1972). (In Polish).

Studies of exchangeable potassium by use of ^{42}K and ^{86}Rb were performed in 117 patients with hyperthyroidism and hypothyroidism. They were also done in persons after treatment of hyperthyroidism and in healthy ones. The total exchangable potassium in hyperthyroidism and hypothyroidism was decreased. The potassium reduction in hyperthyroidism was independent of the presence of thyreotoxic myopathy. The normalization of total exchangeable potassium was found after successful treatment of hyperthyroidism. The measurement of total exchangeable potassium with ^{86}Rb always gives results some 15% higher than ^{42}K. (auth)

757 EFFECT OF ISOTOPIC SUBSTITUTION ON THE BINDING OF TESTOSTERONE TO ITS TRANSPORT PROTEIN. Varsano-Aharon, N.; Ulick, S. (Veterans Administration Hospital, Bronx, NY). J. Clin. Endocrinol. Metab.; 38: No. 3, 486-488(Mar 1974).

The verification of a report in the literature of differences in the binding of 4-^{14}C-testosterone and 1,2,-^{3}H-testosterone to the sex steroid binding globulin of human serum was undertaken by a more precise double label technique. Both labeled steroids were equilibrated with human serum and bound and unbound steroid fractions were separated on Sephadex. There was no significant difference in $^{3}H/^{14}C$ ratio of the bound and unbound steroid and thus no evidence of an isotope effect. ^{14}C-testosterone can be used interchangeably with the tritium labeled steroid in binding studies provided its specific activity is taken into account. (auth)

758 RAPID IN VIVO ASSAY FOR FRIEND POLYCYTHEMIA VIRUS. Hankins, W. D.; Krantz, S. B. (Veterans Administration Hospital, Nashville). J. Nat. Cancer Inst.; 52: No. 4, 1223-1229 (Apr 1974).

An assay for the Friend polycythemia virus (FVP) was developed based on the capacity of plasma from FVP-infected animals to increase greatly the splenic uptake of ^{59}Fe as early as 3 days after infection in fasted BALB/c mice. Our experiments supported the following conclusions: 1) The increase in splenic ^{59}Fe uptake represented a proportional increase in hemoglobin synthesis. 2) The ^{59}Fe response was not due to the presence of erythropoietin in the FVP plasma or to the induction by FVP of endogenous erythropoietin production. 3) The ^{59}Fe assay correlated well with the spleen focus-forming assay. 4) The assay had applicability in monitoring FVP purification procedures and studying physicochemical properties of FVP. (auth)

759 RAPID RADIOIMMUNOASSAY FOR BOTH T_4 AND T_3 IN THE SAME SAMPLE OF HUMAN SERUM. Werner, S. C.; Acebedo, G.; Radichevich, I. (Columbia Univ., New York). J. Clin. Endocrinol. Metab.; 38: No. 3, 493-495(Mar 1974).

A rapid method for determination of total T_3 and T_4 has been developed. Approximately 24 hr are required when a sizable number of samples of human serum is being tested, or 3 hr for a single serum in an emergency. Ethanol extraction, heating of extract with antibody at 40°C, and replacement of double antibody precipitation by PEG precipitation are the main improvements. Final values check within limits of error of the methods between the original method and the present modification. (auth)

760 LIPID LABELING WITH ^{32}P-ORTHOPHOSPHATE AND ^{14}C-ACETATE IN MARINE COPEPODS. Farkas, T. (Univ. of California, Los Angeles); Nevenzel, J. C.; Benson, A. A. Lipids; 8: No. 12, 728-731(1973).

Freshly collected Calanus pacificus were maintained in sea water containing 25 μCi/ml [^{32}P] orthophosphate or 1 μCi/ml [^{14}C] acetate at 10°C for 24 hr. The animals took up label from the environment and incorporated it into various lipid fractions. After incubation with [^{14}C] acetate the order of specific activity of the different lipid classes was: phospholipids > free fatty acids > wax esters > triglycerides. Argentation thin layer chromatography of the fatty acid methyl esters showed that ca. 50% of the activity was in saturated fatty acids and 34% in polyunsaturated acids. When the animals were exposed to [^{32}P] orthophosphate, lysophosphatidyl choline became most heavily labeled, followed by lysophosphatidyl ethanolamine, sphingomyelin, phosphatidyl ethanolamine, and phosphatidyl choline. Comparison of the data obtained with those available for decapods and mammals revealed striking similarities between these phylogenetically distant groups. It is believed that labeling the lipids of marine and freshwater planktonic crustaceans in this way will provide much information about the metabolism of lipids in these organisms. (auth)

761 QUANTITATIVE ASSESSMENT OF REGIONAL VENTILATION AND PERFUSION IN CHILDREN WITH CYSTIC FIBROSIS. Alderson, P. O.; Secker-Walker, R. H.; Strominger, D. B.; McAlister, W. H.; Hill, R. L.; Markham, J. (Washington Univ., St. Louis). Contract AT(11-1)-1653. Radiology; 111: No. 1, 151-155(Apr 1974).

Twenty-five children aged 8 months to 17 years were studied to determine the usefulness of computer-assisted ventilation-perfusion (V-P) scanning in analysis of regional pulmonary function in cystic fibrosis. Ventilation and perfusion scintiphotographs were compared with the patients' radiographs. Regional fractional exchanges of air and relative regional V-P ratios were obtained. Whole-lung air exchange was significantly correlated with standard pulmonary function tests and radiograph scores. Ventilation-perfusion ratio gradients were reversed in patients with predominantly upper zone disease, and regional V-P ratios were uneven in distribution. Quantitative assessment of regional ventilation and perfusion is a useful technique for assessing severity of pulmonary disease in children with cystic fibrosis. (auth)

762 ALTERNATIVE PATHWAY OF CEREBROSPINAL FLUID ABSORPTION IN COMMUNICATING HYDROCEPHALUS: TRANSEPENDYMAL MOVEMENT. James, A. E. Jr.; Strecker, E. P.; Sperber, E.; Flor, W. J.; Merz, T.; Burns, B. (Johns Hopkins Medical Institutions, Baltimore). Radiology; 111: No. 1, 143-146(Apr 1974).

After induction of communicating hydrocephalus in five primates and 30 dogs, autoradiographs following a slow intraventricular infusion of ^{131}I-albumin demonstrated marked transependymal radiopharmaceutical migration in these animals to a much greater extent than in normal subjects. (auth)

MATERIALS

763 (CONF-721231-PA, pp 3-8) PHYSICS WITH LOW ENERGY ACCELERATORS–CHANNELING. Ion Implantation and Hyperfine Interaction Studies. Sharma, R. P. (Tata Inst. of Fundamental Research, Bombay). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

The principles of channeling of charged particles and its application in nuclear physics are surveyed. Ion implantation is also discussed. In hyperfine interaction studies, low-energy accelerators are used to prepare the implanted samples and to locate the impurity position by channeling. (DLC)

764 (GEMP-106-B) HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENT DEVELOPMENT PROGRAMS. Volume II. Materials. First Annual Report. (General Electric Co., Cincinnati, Ohio (USA). Nuclear Materials and Propulsion Operation). 28 Feb 1962. Contract AT(40-1)-2847. 184p. Dep. NTIS $11.25.

Declassified 20 Sep 1973.

Ten development programs are reported: metallic fuel elements capable of operating higher than 1900°C in nonoxidizing atmosphere; evaluation of developed ceramic fuel elements; stabilization of ceramic fuel systems with yttrium-containing compounds to extend temperature limits of operation of BeO-base fuel elements; graphite fuel elements in nonoxidizing atmospheres; coatings for ceramic fuel elements; $UO_{2.9}-Y_2O_3$ evaluation for application in high-performance gas cycle reaction; coated fuel particles (<20 μ) for a dispersion fuel element up to 1650°C; neutron shield materials for high-performance high-temperature (800 to 1650°C) applications; fission product transport processes in ceramic systems; and materials for direct conversion capable of operating above 1650°C. Significant results are as follows: High-temperature brazed joints were made in the refractory metals (Ta, W, Nb, Mo) using vacuum or hydrogen heat treatment. Fuel element specimens of $W-UO_2$ cores clad with Ta have successfully passed proof-tests in He up to 1950°C. Stabilized-fueled BeO fuel elements are dimensionally stable up to 1370°C in air and other atmospheres up to 300 psi static gas pressure; however, the state of oxidation of the fuel phase can have an effect on strength. Substitution of ZrO_2 for part of the Y_2O_3 in $45UO_2-55Y_2O_3$ fuel additive incorporated in a BeO matrix has lowered the fuel loss to 2 to 3% UO_2 after 250 h at 1650°C as compared to ~40% UO_2 after 280 h at 1650°C. Zirconium-uranium carbide fuel, with 52 wt % uranium, was developed and is unaffected by hydrolysis during graphite fuel element fabrication. Procedures were developed for fabricating graphite fuel elements containing up to 2000 mg uranium/cc using this fuel. Uniform, adherent coatings of Y_2O_3-stabilized ZrO_2 were applied to BeO using the vapor deposition technique. A tentative phase equilibrium diagram for the $UO_2-UO_3-Y_2O_3$ ternary system was prepared. Theoretically dense $UO_{2+x} \cdot 3Y_2O_3$ was found to be dimensionally stable, to have good fuel retention up to at least 1900°C, to have strong temperature-dependent electrical properties, and to experience no reduction in strength to 1500°C. High-density spherical particles of UO_2 and Y_2O_3-stabilized UO_2 were prepared in the <20 μ range. $BeO-B_4C$ bodies demonstrated dimensional stability under radiation exposure at 950°C and 5×10^{19} nvt. Be–B bodies demonstrated dimensional stability and strength after exposure to 2.6×10^{19} nvt. An unclad ZrH_y body with N_H 6.6 has excellent hydrogen retention and oxidation resistance to at least 1000 h at temperatures of 650 to 750°C. Reduction of oxygen-to-metal ratios in uranium and zirconium oxides very favorably affects their thermoelectric properties. (DLC)

765 (GEMP-270-B) THIRD ANNUAL REPORT: HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENTS DEVELOPMENT PROGRAMS. Volume II. Materials. (General Electric Co., Cincinnati, Ohio (USA). Nuclear Materials and Propulsion Operation). 28 Feb 1964. Contract AT(40-1)-2847. 235p. Dep. NTIS $13.75.

Declassified 21 Sep 1973.

This volume covers fourteen materials development programs: studies of substoichiometric urania and urania solid solutions above 1800°C and their compatibility with refractory metals; $UO_{2+x} \cdot 3Y_2O_3$, a composition having high-temperature stability in reducing, inert, and oxidizing atmospheres; the physico-chemical properties of high melting borides and carbides and their stability in high-temperature gaseous environments; coated fuel particle preparation and evaluation in BeO matrices; refractory metal fuel element materials development for greater than 1900°C operation in nonoxidizing atmospheres; oxidation-resistant fuel element materials for operation above 1200°C in air; graphite element materials development to improve the processing procedures, reliability, and service capabilities; the effect of high fuel burnup on stabilized UO_2 fuel systems and on stabilized fuel–BeO-matrix fuel elements; coatings for ceramic fuel elements to inhibit fission product release; stabilization of UO_2 in ceramic fuel elements to extend high-temperature limits; fission product migration in ceramic systems; development of new or improved reactor control, reflector, and shield materials; direct conversion high-temperature materials for use in high-temperature reactors; and high-flux reactor gaseous fuel materials research. (DLC)

766 (HW-84611) REACTOR AND FUELS LABORATORY QUARTERLY REPORT ON CERMET RESEARCH AND DEVELOPMENT ACTIVITIES, JULY–SEPTEMBER 1964. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). [nd]. Contract AT(45-1)-1350. 95p. Dep. NTIS $7.75.

Declassified 28 Aug 1973.

The research on UO_2-W cermet fuels included: thermal cycling behavior, density, fuel element design and fabrication, joining, UO_2 dispersion in W, nondestructive testing, and irradiation of fuel plates. (DLC)

767 DEFORMATION OF A ONE-DIMENSIONAL MOLECULAR CRYSTAL WITH THE PRESENCE OF ELECTRON EXCITATION. Kislukha, N. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 112-116(Jan 1974). (In Russian).

Electron excitation in a one-dimensional molecular chain is investigated with its deformation taken into account. It is shown that the consideration of the deformation accompanying the electron excitation may result in localization of electron excitation in the central part of the chain or at its ends. The conditions under which this occurs are determined. (auth)

768 ANALITICHESKIE VOZMOZHNOSTI METODA VNUTRENNEGO TRENIYA. (Analytical Possibility of the Internal Friction Method. Conference Held in Tbilisi, USSR, October 1971). Tavadze, F. N. (ed.). Moscow; Izdatel'stvo Nauka (1973). 196p. (CONF-711083-).

Problems of the investigation of relaxation processes in solids, interaction of point defects, phase conversion, superconducting transitions, and the mechanism of internal friction were examined. Twenty-five papers are included; one was abstracted separately. (DLC)

For an abstract of an individual paper see: 875.

769 OUT-OF-PILE INVESTIGATIONS OF FISSION PRODUCT-CLADDING REACTIONS IN FAST REACTOR FUEL PINS. Aitken, E. A.; Evans, S. K.; Rubin, B. F. (General Electric Co., Pleasanton, CA). pp 269-285 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Type 316 stainless steel fuel pins containing fuel at a known stoichiometry and additives of cesium oxide, Te, I, and Mo were heat treated in a temperature gradient between 550 and 1100°C for 100 hours. The distribution of each additive along the temperature profile was measured with the aid of tracer isotopes. The reactions of the fission products with the fuel and cladding were determined by metallographic examination. Cs was found to react with I, Te, and fuel. The Cs–fuel reaction was dependent on the stoichiometry of the fuel. Te reacted with the fuel in the presence or absence of Cs. However, the distribution of Te was affected by Cs-to-Te ratio. Intergranular attack of the stainless steel occurred between 750 and 950°C when tellurium was present and the fuel was stoichiometric. Cs oxide caused intergranular attack when the oxygen potential was higher than the potential characteristic of stoichiometric fuel. I and Mo additions with or without Cs did not induce intergranular attack. If the fuel was hypostoichiometric, none of the additives produced intergranular attack. The implication of these data on the nature and mechanism of cladding attack in irradiated mixed oxide fuels is discussed. (12 fig) (auth)

770 DEFECTS IN CRYSTAL CREATED BY ION BOMBARDMENT: THEORY AND SIMULATION. Torrens, I. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. (Paris), Colloq.; No. 5, 1-7(1973). (In French).

From centenary congress of the French Physical Society; Vittel, France (28 May 1973).

The damage processes involved in the penetration of an energetic ion in a crystalline solid are reviewed qualitatively. Different methods of studying the mechanisms of damage and defects

created are described, and the role of computer simulation in the comparison of theory and experiment is discussed. (FR)

771 HARD METALS IN MODERN TECHNOLOGY. Schumacher, G.; Ostermann, G. (Krupp (Friedr.) GmbH, Essen, Ger.). Kobalt; No. 4, 69-81(1973). (In German).

A survey is given of the progress achieved within the last few years with regard to the production, properties, and application (machining and noncutting treatment of metals, stone working machines and rock drills, parts subject to wear) of hard metals belonging to the group of ultrahard, highly wear-resistant materials. Numerous illustrations are added to the examples given. Considering cutting tools, the importance of fine-grain alloys and TiC-coated qualities is pointed out and their efficiency is demonstrated by examples of machining processes. (GE)

772 INTERACTION WITH THE SURROUNDING MEDIUM OF POWDERS IN HIGH-TEMPERATURE SPRAYING. Sharivker, S. Yu.; Asmakhov, E. A.; Krasnov, A. N.; Garda, A. P. (Inst. of Problems in Materials Science, Kiev). Zashch. Pokrytiya Metal.; No. 7, 196-203(1973). (In Russian).

The interaction of high-temperature currents on powders of Ni, ZrC, Zr, and NbC, leading to their heating and speeding up, is examined. This is the basis for tight and firm bonds with the foundation coating. The technological variables in sprays used to obtain high-quality detonation coatings are described. (tr-auth)

Ceramics and Cermets

Refer also to abstracts 104, 193, 195, 282, 698, 907, 1932, 2045, 2046, 2050, 2051, and 2151.

773 (ANL-8082) ENTHALPY OF MOLTEN URANIUM-PLUTONIUM OXIDES. Leibowitz, L.; Fischer, D. F.; Chasanov, M. G. (Argonne National Lab., Ill. (USA)). Feb 1974. Contract W-31-109-eng-38. 19p. Dep. NTIS $4.00.

Equipment was developed and used to measure the high-temperature enthalpy of uranium-plutonium oxide. Measurements have been made of the enthalpy of $(U_{0.8}Pu_{0.2})O_{1.97}$ to about 3000°K. Attempts at measurement for this fuel composition (O/M = 1.97) at still higher temperatures resulted in severe attack of the tungsten container used. Reduced oxide (O/M ≅ 1.92) was then obtained and used in measurements up to about 3300°K. Within experimental errors the heat capacity of solid oxide (below ~3000°K) is the same for both values of O/M examined. The heat of fusion of $(U_{0.8}Pu_{0.2})O_{1.92}$, based on the data now available, is about the same as that for UO_2, which is 18 kcal/mol. The heat capacity of the molten mixed oxide is also about the same as that of UO_2, which is 32.5 cal/mol°K. (9 fig) (auth)

774 (BARC/I-67) SPONTANEOUS SWELLING IN MATERIALS CONTAINING INERT GASES. Tiwari, G. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 14p. INIS.

Dimensional instability of fuel elements due to the growth and coalescence of gas bubbles is an important factor affecting the safety and economy of power reactors. The in-pile behavior of gas bubbles is closely related to the post-irradiation swelling of fuel elements. Therefore, theories on the post-irradiation swelling provide a means of interpreting behavior of fuel during service. Current concepts of post-irradiation swelling are reviewed briefly. The validity of equation $p = 2\gamma/\gamma$ for gas-solid system is discussed. It is pointed out that a bubble enclosed within a solid cannot achieve equilibrium inside the solid. The motivation for the growth is suggested to be expansion of gas inside the bubble. A qualitative explanation for the characteristic feature of the growth of gas bubbles is presented. (auth)

775 (COO-3420-3) CERAMIC RESEARCH ON TRANSFORMATIONAL SUPERPLASTICITY AND STOICHIOMETRY EFFECTS ON FRACTURE. Research Progress Report, June 1, 1973-May 31, 1974. Bradt, R. C.; Hoke, J. H. (Pennsylvania State Univ., University Park (USA). Dept. of Material Sciences). 1 Mar 1974. Contract AT(11-1)-3420. 17p. Dep. NTIS $4.00.

The study of transformational superplasticity in pure Bi_2O_3 has been completed while the superplasticity of the Bi_2O_3-Sm_2O_3 eutectoid is nearing completion. Results indicate that transformational superplasticity agrees with the internal stress model of Greenwood and Johnson. Additional criteria for the phenomenon were proposed and found to be met in Bi_2WO_6, which exhibits the largest transformational superplasticity of any compound to date and peculiar thermal expansion "growth" characteristics as well. Observations on TiO_{2-x} shows an 80% decrease in fracture surface energy from $TiO_{2.000}$ to $TiO_{1.980}$. (7 figures). (DLC)

776 (HW-80538) HIGH TEMPERATURE IRRADIATIONS OF CERMET FUEL PLATES. Summary Report, Proposal C-127236. Horn, G. R.; Pember, L. A. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). Jan 1964. Contract AT(45-1)-1350. 33p. Dep. NTIS $4.75. Declassified 28 Aug 1973.

Two fully enriched UO_2-W plates were irradiated under conditions so that plate temperatures > 5000°F were achieved. Fuel losses were minor, but Cs and I were released from one plate. (DLC)

777 (INIS-mf-1220) ZIRCONIUM OXIDE REDUCTION BY MAGNESIUM IN SOLUTION IN MOLTEN ZINC. Haydt, H. M. (Sao Paulo Univ. (Brazil). Escola Politecnica). 1972. 88p. (In Portuguese). INIS. Thesis.

The preparation of zirconium through a pyrometallurgical process of reduction of its oxide by magnesium, in solution in molten zinc is described. By appropriate control of conditions or reagents, it is possible to achieve the partition of a metal between two immiscible liquid phases: one metallic and another one of fused salts. The process involves two separated steps: (a) reduction of the zirconium oxide by magnesium as the reductant, in solution with zinc, used as the liquid metal phase of a heterogeneous liquid system, immiscible with the fused salt mixture, in which the oxide is introduced, and (b) vacuum distillation of the zinc-magnesium-zirconium alloy resultant of the reduction. In this operation, zinc and magnesium are recovered as the distilled material, the zirconium remaining in a sponge form. The experimental work consisted essentially of two parts. The purpose of the first part was to investigate, through preliminary experiments, the effect of the variables of the process on the maximum zirconium oxide charge to be reduced in the equipment used, in order to transfer the maximum amount of metal to the liquid metal phase: three series of experiments were run, differing the amount of zirconium oxide loaded. In the second part, the loads of zirconium oxide were identical to one of the series of the first part and runs were designed to confirm the former results, and, if possible, to improve them, by changing the experimental loading procedure. The best reduction results were achieved by using minus 100 mesh zirconium oxide, with the reductant-solvent liquid metal and the selected flux being distributed above them. At the end of the distillation step, an attempt was made to open the system, but the argon atmosphere was inadequate to assure the necessary protection for the zirconium-rich sponge. Two procedures were adapted to avoid the pyrophoricity of the sponge metal: the substitution of argon by helium and the immersion of the material in oil. The process studied allows the direct production of magnesium-zinc-zirconium alloys, provided that iron contamination is avoided. (INIS)

778 (JUL-1030-RW) INVESTIGATION OF FLOW MECHANISMS IN CONICAL MODELS OF FLUIDIZED BEDS AND THE TRANSFER OF THE RESULTS TO HIGH-TEMPERATURE-COATING BEDS. A Study on Fluidized Bed Coating of Nuclear Fuel Kernels. Kalthoff, B.; Gyarmati, E.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe). Dec 1973. 108p. (In German). Dep. NTIS (U. S. Sales Only) $8.50.

Thesis. Submitted by B. Kalthoff to Technische Hochschule, Aachen (West Germany).

The different states of movement of the fluid-solid particle system as occurring in coating of nuclear particle fuel in conical fluidized beds determine the transfer of momentum, heat and mass in the fluidized bed. To know the flow characteristics therefore is essential for the understanding of the complex processes which take place during coating. As experimental studies in actual coaters initially were impossible owing to the high temperature levels of up to 2000°C, information on characteristical behaviour of the fluidized bed was obtained from geometrically similar model beds. Based on principles in the mechanics of similarity the fluid-solid particle system was selected. Hence results obtained in model tests could be correlated to hot fluidized beds by means of a dimensionless characteristic number describing the fluid-solid system. A second combination of characteristic numbers allows the characterization of the three states of a fluidizing regime: spouting, bubbling and slugging. For examining the model test results in hot beds a measuring device was developed applicable to both cold model beds and actual fluidized bed coaters; pressure oscillations originating in the beds could be made visible by means of electronics and their frequency be measured. Coating experiments with different batches and at different temperature levels rendered this frequency to decrease with increase in bed height. Thus the frequency is an important index for the momentary state of fluidization of the fluid-solid particle system. (auth)

779 (NAA-SR-6175) FABRICATION OF PLATE TYPE CORE ELEMENTS FOR THE TORY II-A REACTOR. Langrod,

K.; Carniglia, S. C. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1961. Contract AT(11-1)-Gen-8. 69p. Dep. NTIS $5.50.

Declassified 27 Nov 1973.

The fabrication of fueled and unfueled plate type core elements, and of bushing type alignment keys for use in an insert test in the Tory II-A reactor is described. Production-control and inspection methods, to determine chemical composition; fuel content; density; mechanical strength; extent, if any, of cracks, chips, and inclusions; and variance from specified dimensions, fuel loss, and dimensional stability, under specified test conditions, are also reported. Accountability procedures are included for special materials used. (auth)

780 (NAA-SR-Memo-5905) BERYLLIUM OXIDE FOR MODERATOR AND FUEL APPLICATIONS. Carniglia, S. C.; Hove, J. E.; Riley, W. C. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Nov 1960. 12p. Dep. NTIS $3.00.

Declassified 26 Nov 1973.

Research on the properties of BeO and Be–UO_2, and on the hot pressing of BeO for Project Pluto (an air-cooled, high-temperature reactor) is reported. The properties include thermal properties, mechanical properties, compatibility, stability, oxidation, and vaporization. (DLC)

781 (PWAC-498) FABRICATION OF LOW DENSITY URANIUM NITRIDE FOR HIGH FISSION GAS RELEASE. Caplow, S. D.; Lindemann, G. W.; Schilling, A. C. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). Sep 1965. Contract AT(30-1)-2789. 34p. Dep. NTIS $4.75.

Declassified 5 Sep 1973.

A method of fabricating low-density uranium nitride with a structure optimized for maximum fission gas release was demonstrated on a laboratory scale. The structural features optimized are: 1) the virtually complete elimination of closed, transgranular porosity and 2) a reduction of the trapping sites for fission gases. The process involves three stages: 1) the fabrication of high-density large-grained UN pellets by liquid phase sintering, 2) the chemical comminution of these pellets into coarse, essentially single-grained particles, and 3) the fabrication of a low density UN fuel body having the desired properties. As compared to earlier methods of fabricating low-density UN, the method described resulted in 95% and more of the total porosity open to the surface, and a twenty-fold reduction in the grain boundary surface area. (16 figures) (auth)

782 (SLA-73-8004) HIGH DENSITY DAMAGE IN Al_2O_3 BY LOW ENERGY PROTON IMPLANTATION. Arnold, G. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). [nd]. 30p. (CONF-740402-5). Dep. NTIS $4.50.

From topical meeting on technology of controlled nuclear fusion; San Diego, California, USA (16 Apr 1974).

Optical absorption at 204 nm is produced in $\alpha-Al_2O_3$ by displacement of lattice atoms. For ion implantation at energies in the 45-250 keV range, the concentration of defects responsible for the 204 nm absorption is found to be anomalously large for H^+-ion implantation relative to higher mass ions. A mechanism for the stabilization of the defects produced by H^+ ions is proposed which is based on the large electron-capture cross section of the H^+ ion in the same portion of the ion track in which lattice defects are being produced. The anomalously large production of defect centers by low-energy protons allows simulation studies of the effects of high-fluence 14-MeV neutrons in Al_2O_3. (auth)

783 (WARD-NA-3045-8) PROPERTIES OF CHROMIUM AND TITANIUM CARBIDES AND THEIR APPLICATION IN FAST BREEDER REACTORS. Wu, P. C. S. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Apr 1974. Contract AT(11-1)-3045. 24p. AT.

The need for low-friction contact surfaces in liquid sodium cooled nuclear systems has generated interest in the chromium and titanium carbides for surface coating application. An evaluation was made of the thermal stability and sodium compatibility of chromium and titanium based carbide coatings. Properties including resistance to neutron irradiation degradation of these materials are also discussed. Chromium carbides with their high thermal expansion coefficient, high thermal conductivity, low friction coefficient, and density may be preferred as the carbide phase for the coating of Type 316 stainless steel duct load pads. Titanium carbide with a cubic structure has an isotropic change in dimension during neutron irradiation, a property which is superior to the noncubic carbides such as Cr_7C_3 which have anisotropic elastic properties. Although both carbides have good sodium compatibility, titanium carbide is thermodynamically more stable than the chromium carbides. Therefore, carbonization of nonstoichiometric titanium carbide will cause decarburization of the stainless steel in the coolant system. Furthermore, carburization of the binder (molybdenum) of the titanium carbide coating by the formation of Mo_2C in a high carbon activity sodium system will accelerate the deterioration of the carbide coating. (11 figures, 25 references) (auth)

784 RADIATION TOLERANCE OF BUBBLE-DOMAIN MATERIALS AND DEVICES. Williams, R. A.; Henry, R. D.; Chen, T. T.; Archer, J. L. (Rockwell International, Anaheim, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 229-233(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Following a brief outline of magnetic bubble domain technology and possible radiation effects, results of radiation effects experiments are presented. Permanent damage experiments on materials consisted of characterizing samples of $Y_3(FeGa)_5O_{12}$, $Er_3(FeGa)_5O_{12}$, and $(YGdTm)_3(FeGa)_5O_{12}$ films before and after exposure to neutrons from a TRIGA reactor and to ^{60}Co gammas. Parameter measurements included saturation magnetization, wall energy, defect density, wall mobility, coercivity, and saturation velocity. No significant changes in these parameters were observed after 10^{15} n/cm^2 (1 MeV equivalent) and 5×10^7 rads. Permanent damage experiments on devices included measurements of propagation and annihilation margins, and domain sensor output (for shift registers) before and after exposure to reactor neutrons and ^{60}Co gammas. Again no significant change was found after 4×10^{14} n/cm^2 (1 MeV equivalent) and 5×10^7 rads for devices with hard-bubble suppression. Magnetoresistive parameters of a thin, permalloy domain-sensor film were also unchanged after 10^{15} n/cm^2 and 5×10^7 rads. Information stored in a shift register was read electrically immediately before and after exposure to a 30 ns pulse of 1.5-MeV electrons with a dose of 3×10^4 rads (Si) and found unchanged. A similar experiment, using optical determination of the stored information, indicated no change after a 1.7×10^5 rad pulse. (8 fig) (auth)

785 ION-IMPLANTED EFFECTS IN NONCRYSTALLINE SiO_2. Arnold, G. W. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 220-223(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Impurity ions (H^+, He^+, B^+, O^+, Ar^+, Kr^+, and Xe^+) were implanted in high-purity vitreous silica and their production of and interaction with implantation damage was studied by optical absorption techniques. An absorption band at 245 nm (B_2-band) is produced by all ions except H^+. The implantation of H^+ greatly reduces the B_2-band absorption intensity produced either by prior or subsequent sample implantation with heavier ions. For ions other than H^+, the intensity of the B_2-absorption increases with increasing ion mass for a given ion fluence and suggests that the defect giving rise to this absorption is generated by ion energy going into displacement processes. The spectral position of the implantation-induced B_2-band is identical with that of a band found in impure as-manufactured fused silica. The band in impure silica is believed to be due to a center consisting of a trivalent metallic impurity (e.g., Al^{3+}) substituting for Si^{4+} and an adjacent oxygen vacancy. Results suggest that the implantation-induced defect producing the B_2 band in high-purity silica is an oxygen vacancy at which the binding electrons of the two adjacent Si atoms can be trapped. If the B_2-band is also associated with SiO_2/Si interface states in MOS devices as has been suggested, the present results may offer a possibility for reducing the density of these states by H^+-implantation. (auth)

786 STOICHIOMETRIC EFFECTS IN IRRADIATED URANIUM–PLUTONIUM OXIDE FUEL. Johnson, C. E.; Johnson, I.; Blackburn, P.; Battles, J. E.; Crouthamel, C. E. (Argonne National Lab., IL). pp 1-30 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Stoichiometric effects in irradiated mixed urania–plutonia fuel are of major significance in determining overall fuel performance and fuel life. The paper discusses the results of extensive studies carried out to understand the various ways in which oxygen can interact with cladding, fuel, and fission products under irradiation conditions. Corrosion of fuel cans by fission products is also discussed. (5 tables, 12 fig) (auth)

787 COMPOSITION AND CHEMICAL STATE OF IRRADIATED OXIDE REACTOR FUEL MATERIAL. Findlay, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 31-39 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The composition of irradiated fuel may be calculated readily from the established fission yields and cross-section data. Examples of calculations undertaken by computer are given and differences due to the type of fission, capture cross sections, and irradiation times are considered. The calculated compositions are applied to oxide fuels to establish the change in oxygen balance occurring with burnup. Some discussion of the uncertainties is given with reference to the behavior of cesium, rubidium, and niobium. The redistribution of oxygen under the radial temperature gradient of a fuel element is considered in relation to its effect on oxygen to metal ratios and oxygen potentials. (auth)

788 REDISTRIBUTION OF URANIUM AND PLUTONIUM IN MIXED-OXIDE FUELS DURING IRRADIATION. O'Boyle, D. R.; Meyer, R. O. (Argonne National Lab., IL). pp 41-66 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

When mixed-oxide fuels are irradiated under normal operating conditions, radial and axial redistribution of the oxygen, uranium, plutonium, and fission products occurs, which significantly affects the performance of the fuel element. The paper develops the theory for vapor-transport and solid-state-diffusion controlled redistribution and summarizes recent experimental evidence of actinide redistribution. The experimental data, which cover a range of oxygen-to-metal ratios from 1.90 to 2.00, suggest that radial actinide redistribution is controlled by a vapor-transport process and is closely related to central-void formation. Slightly hypostoichiometric fuels irradiated at moderate linear power ratings (360 to 530 W/cm) show an enhanced plutonium concentration near the central void that is typically 35 to 50% greater than the initial concentration. Markedly hypostoichiometric fuels show significantly less redistribution, and unrestructured fuels show no actinide segregation. For burnups between 1 and 11 at. %, no appreciable effect of burnup on redistribution is observed. The effect of actinide redistribution on allowable power rating is briefly discussed and several analytical models are described for predicting the extent of uranium and plutonium redistribution as a function of time and temperature. (14 fig, 41 references) (auth)

789 DISAGREEMENT BETWEEN THEORETICAL AND EXPERIMENTALLY-DETERMINED INERT GAS FISSION YIELDS IN A FAST-NEUTRON ENVIRONMENT: ANALYSIS PERFORMED ON RAPSODIE FUEL. Kryger, B. (CEA, Fontenay-aux-Roses, France). pp 77-82 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Observations on $(U,Pu)O_2$ fuels irradiated in Rapsodie (experimental irradiations in the core blanket) which released large amounts of gas revealed that the actual volumes of gas released ($^{83+84+85+86}Kr$, $^{131+132+134+136}Xe$) were larger than the calculated volumes. The discrepancy was particularly large in the 11-11-0002 Fortissimo assembly, where all the pins exhibited the same phenomenon. At this stage of the study, it was only possible to note the anomaly, which made it difficult to determine the true volume fractions released. To surmount this obstacle the authors have drawn up an experimental balance of true fission gas concentrations (gas released plus gas contained). (4 tables) (auth)

790 OXYGEN REDISTRIBUTION IN LMFBR FUELS. Evans, S. K.; Aitken, E. A. (General Electric Co., Pleasanton, CA). pp 83-86 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The behavior of oxygen in hypostoichiometric mixed oxide fuels in a temperature gradient is discussed from experiments performed out-of-pile. Oxygen migration toward the cold end of the temperature gradient has been consistently observed. However, the degree of distribution, characterized by the heat of transport, is a function of the overall stoichiometry and the Pu content of the fuel. An empirical relation between the heat of transport and the overall stoichiometry of typical LMFBR oxide fuels has been formulated and used to predict the O-to-M profile under a given set of irradiation conditions. Cladding oxidation imposes an additional constraint and must be properly accounted for in predicting O-to-M profiles. Other reactions involving fission products may influence the O-to-M profile under certain conditions. (auth)

791 MODIFICATION OF THE OXIDATION POTENTIAL OF MIXED OXIDES $(U,Pu)O_2$ AS A FUNCTION OF BURN-UP. Schmitz, F.; Marticorena, J.; Dean, G. (CEA, Fontenay-aux-Roses, France). pp 87-98 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The oxidation potential of mixed oxide (represented by $\Delta\bar{G}_{(O_2)}$) is a key parameter of this nuclear fuel, and varies with the O/U + Pu ratio which develops during irradiation. It is shown that in pure mixed oxides the variation of $\Delta\bar{G}_{(O_2)}$ can be linked to the valences of uranium and plutonium up to about 30% plutonium. In irradiated fuels this situation is changed by the dissolution of certain fission products in the $(U,Pu)O_2$ matrix. In order to avoid handling difficulties resulting from the radioactivity of irradiated fuels, the investigations are conducted mainly on nonradioactive samples simulating the chemical composition of a fuel after irradiation. It was possible to confirm certain results on actually irradiated fuels. (6 fig) (auth)

792 DEVELOPMENT OF CARBON ACTIVITY AS A FUNCTION OF BURN-UP IN A CARBIDE FUEL. Lorenzelli, N.; Marcon, J. P. (CEA, Fontenay-aux-Roses, France). pp 99-113 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The thermodynamic properties of UC and (U,Pu)C fuel determine the possible carburization of the stainless steel can by the fuel, release of volatile fission products (Cs, I, Te, Ba, Sr), and chemical behavior in the presence of sodium. Although the properties of UC and (U,Pu)C are fairly well known, it is nevertheless important to consider the effect of fission products on them, since at a burnup of 100,000 MWd/t the concentrations reach several per cent and are capable of modifying the UC matrix. One of the parameters which best characterizes the thermodynamic properties of a carbide is carbon activity. As the latter by definition depends to a considerable extent on the C/U ratio, its development as a function of burnup is investigated from several points of view. (auth)

793 SOME PHASE EQUILIBRIA AND THERMODYNAMIC CONSIDERATIONS FOR IRRADIATED OXIDE NUCLEAR FUELS. Potter, P. E. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). pp 115-155 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Recent published data on the phase equilibria and thermodynamics of the appropriate oxide systems. First, the binary systems, U–O and Pu–O and the ternary system U–Pu–O and, secondly, the systems of the major fission products with U–O and Pu–O are considered. (36 fig, 78 references) (auth)

794 FORMATION OF PHASES AND DISTRIBUTION OF FISSION PRODUCTS IN AN OXIDE FUEL. Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 157-166 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

The composition and distribution of different metallic and ceramic fuel component–fission product, fission product–fission product, and fission product–cladding material inclusions in a uranium dioxide and a mixed oxide fuel investigated by microprobe analysis are given. The radial dependence of the metallic Mo–Tc–Ru–Rh–Pd inclusions is reported, as are U–Pu–noble metal and Pd–Sn–Te inclusions and Fe-rich precipitations together with Pd, Ni, Mo, or Tc. Several ternary or quaternary oxide phases containing Cs, Sr, Ba, Zr, Mo, Ce, or Cr occurring in the fuel and near the rim are classified. (5 fig, 24 references) (auth)

795 X MICROANALYSIS OF OXIDE $(U,Pu)O_{2+x}$ SIMULATING VARIOUS IRRADIATION LEVELS. de Keroulas, F.; Calais, D.; Schmitz, F. (CEA, Fontenay-aux-Roses, France). pp 167-177 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Metallography and X microanalysis reveal that fission products are distributed in the following three ways: (a) In the form of two types of metallic inclusions. The first type (termed phi_1) has the following mean composition: Ru (55 ± 5%), Mo (35 ± 5%), Rh ≃ 10%, Pd ≃ 3%, Re ≃ 3%. The second type (termed phi_2) is composed of pure Re. (b) In solution in the matrix. (c) In the form of a grey phase containing Ba and Zr (Ba/Zr ratio ≃ 2) but no other fission product nor U or Pu. This phase is of the barium zirconate $(BaO)_2ZrO_2$ type. As regards the phi_1 phase, an increase in the

O/(U + Pu + soluble F.P.) ratio or in temperature results in oxidation of Mo. In addition, annealing over 1600°C causes demixing with the appearance of a metallic phase of the type $(U,Pu)Pd_3$ through reaction of palladium with the mixed oxide. (10 fig) (auth)

796 MIGRATION OF RADIOACTIVE FISSION PRODUCTS IN $(U,Pu)O_2$ FUELS. Mouchnino, M. (CEA, Fontenay-aux-Roses, France). pp 179-189 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The radial spectrometry technique has made it possible to study the distribution of radioactive fission products in various types of mixed oxides irradiated under widely differing conditions. The aim of applying this form of spectrometry is to derive criteria for temperature and stoichiometry and to furnish data additional to those yielded by the post-irradiation examination of the fuel. (6 fig) (auth)

797 DISTRIBUTION OF FISSION PRODUCTS AND LOCALIZATION BY GAMMA SPECTROMETRY DURING AND AFTER IRRADIATION. de Contenson, G.; Monier, J.; Vignesoult, N. (CEN de Saclay, Gif-sur-Yvette, France). pp 191-200 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Gamma spectrometry makes it possible to identify and enumerate gamma-emitting radioactive atoms. It is used during and after irradiation to determine the longitudinal and radial movement of the fission products. Examinations during irradiation are carried out directly through the irradiation device after each reactor cycle or, in the case of accident, immediately after unloading. These examinations reveal accumulations of fission products accompanying movements of matter, for example, in the case of fuel exhibiting core-melt characteristics. The post-irradiation examinations, performed in a hot cell, are carried out longitudinally and transversally on the pins before any destructive investigation is made, and radially on micrographic sections. These sensitive analyses make it possible to localize, after irradiation, fission products both in the UO_2 and in the fuel element structures. Examples of localization of fission products are given for the case of an oxide which has undergone limited melting. (auth)

798 MICROWAVE ANALYSIS OF METALLIC FISSION PRODUCTS IN FUEL ARRANGED IN ORDINARY WATER GEOMETRY AND OPERATING WITH A FUSED ZONE. Bazin, J.; Perrot, M.; Vignesoult, N. (CEN de Saclay, Gif-sur-Yvette, France). pp 201-210 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behavior and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The distribution of metallic fission products was studied in experimental fuel elements in ordinary water geometry (UO_2 clad with Zircaloy). The elements had been taken to burnups of 30,000 to 60,000 MWd/t U with a continuous limited fused zone. Some of the elements had been cooled rapidly, others slowly. The microwave analyses were aimed at determining the qualitative and quantitative composition of precipitated fission products (globular fission products, slugs collected in the central stacks, grey phases) and the radial distribution of fission products in solution in the UO_2 matrix, principally zirconium. Results are correlated with metallographic observations (by microscopy and autoradiography). (8 fig.) (auth)

799 MIGRATION OF FISSION PRODUCTS THROUGH REACTOR FUEL MATERIALS. Findlay, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 211-220 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The mechanisms for the migration of fission products in nuclear fuel materials, principally oxides, are discussed. Fission products are released from surface regions by fission recoil; further release of fission products and fuel material is induced by a "knock-out" process in which atoms are released by interaction with fission product tracks that traverse the surface. This process imparts mobility also to fission product atoms in the bulk of the fuel matrix. Insoluble fission products segregate into second phases such as gas bubbles or inclusion phases. Fission product gas bubbles are found intragranularly and at grain boundaries. Release of gas occurs principally from the grain boundaries by mechanisms involving interlinkage of gas bubbles or by boundary sweeping. The release characteristics of short-lived fission products are determined by their short lifetime in the fuel material, which allows description by simple diffusion models. The behavior of I, Te, and probably the alkali metals, is closely analogous to that of the noble gases. Most fission products are expected to be freely mobile at elevated temperatures or, at low temperatures, by radiation-induced diffusion, although many are insufficiently volatile for transfer in the gas phase. (28 references) (auth)

800 CONTRIBUTION TO THE STUDIES OF THE FISSION GASES RELEASED FROM IRRADIATED URANIUM OXIDE PELLETS. Klima, J.; Podest, M.; Vins, V. (Nuclear Research Inst., Rez, Czech.). pp 221-224 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The postirradiation diffusion coefficient of fission gases released during annealing at 1200 to 1600°C was measured on samples of thermally processed dense UO_2. The characteristic value of the material, which was sintered to practically the same density (98% T.D.), was the grain size, which ranged from 10 to 100 μm. A clear dependence of ^{133}Xe release on the regime of thermal processing of the original pellets before irradiation was observed. In the mentioned region of the grain size of the original material the value of the diffusion coefficient ranged from 5×10^{-11} to 1×10^{-7} cm^2/s. For samples in the grain size range of 20 to 40 μm the same activation energy was established ($E_A \pm 50{,}000$ kcal/mol). An interrelation exists between the D_0 and the average grain size, which has not yet been defined more exactly. (auth)

801 Pu, U REDISTRIBUTION IN $(U,Pu)O_2$ FUELS BY TEMPERATURE GRADIENTS. Adamson, M. G.; Aitken, E. A. (General Electric Co., Pleasanton, CA). pp 225-235 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

A predictive model of the time-dependent evolution of radial Pu/U + Pu gradients in operating non-molten mixed oxide fuels is being developed. This model is based on preferential evaporation-condensation and vapor transport of metal-bearing species either along cracks and porosity channels within the fuel or inside closed pores migrating up the temperature gradient; equilibrium thermodynamics are applied to calculate the continually changing vapor composition over the hot fuel. Predictions of the model are used in combination with recent in-pile experimental data (from non-molten mixed oxide fuel pins irradiated in EBR-II from 0.2 to about 11 at. % burnup at varying powers) to delineate the key parameters in radial actinide redistribution. A correlation between fuel stoichiometry (O-to-Pu ratio) and the degree of redistribution (described by an enrichment factor γ_{Pu}) has been identified; however, the degree of restructuring of the fuel—as determined by the peak linear power rating, time at this power, and the initial fuel density—also has a strong influence on the final value of γ_{Pu}. Certain kinetic features of the process and intended modifications to the present model are discussed, and evidence for axial actinide vapor transport in an irradiated annular fuel is also presented. (6 fig) (auth)

802 FUEL/CLADDING COMPATIBILITY OF STAINLESS STEELS WITH GAS AND SODIUM-BONDED URANIUM PLUTONIUM CARBIDE FUELS. Goetzmann, O. (Kernforschungszentrum, Karlsruhe, Ger.); Ohse, R. W. pp 255-268 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

An assessment is made of the compatibility of stainless steels with gas and sodium-bonded uranium plutonium carbide fuels by considering compatibility results, thermodynamic data, and phase relationships. The fuel stabilization is considered both on the basis of the carbon potential of the fuel and the buffering carbides and on their location in the appropriate phase diagram. The influence of the radial temperature gradient and burnup on the carbon potential of the fuel is discussed. Finally, clad carburization, carbon activity, and solubility in steel and sodium and its effect on the mechanical properties of the steel are considered with special attention to carbon transfer and the effect of oxygen dissolved in sodium. (11 fig, 44 references) (auth)

803 REACTIONS AT THE CLAD (STAINLESS STEEL)/FUEL (MIXED OXIDE $(U,Pu)O_{2\pm x}$) INTERFACE IN FUEL ELEMENTS IRRADIATED WITH FAST NEUTRONS. Calais, D.;

Conte, M.; de Keroulas, F.; Le Beuze, R. (CEA, Fontenay-aux-Roses, France). pp 287-297 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The problems of compatibility between cladding (stainless steel) and fuel (mixed oxide, $(U,Pu)O_{2\pm x}$) that arise in fast reactors are associated largely with the development of a clearly defined reaction zone at relatively high burnups (50,000 MWd/t). The evolution of this reaction zone can shorten the lifetime of a fuel element. The purely chemical aspects of the "oxide-clad" reaction are emphasized and guidelines suggested for out-of-pile simulations designed to provide a good interpretation of the mechanisms involved. The analysis bears exclusively on irradiations with fast neutrons. No influence of neutron energy on the development of the oxide-clad reaction is evident. However, micrographic observations indicate that, other things being equal, the thickness of the reaction zone is considerably greater when irradiation is with fast neutrons than otherwise. In laying down these guidelines for simulation experiments, micrographic examinations and X-ray microanalyses of reaction zones at the fuel-clad interface were used. (auth)

804 ROLE OF CESIUM IN CHEMICAL INTERACTION OF AUSTENITIC STAINLESS STEELS WITH URANIUM PLUTONIUM OXIDE FUELS. Ohse, R. W.; Schlechter, M. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). pp 299-314 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The role of Cs in fuel/cladding interaction of austenitic stainless steels with mixed oxide fuels is discussed by considering the phase relationships, oxygen potentials, and defect structures of the oxide layers and the oxygen-containing liquid multicomponent Cs phase. The possible reaction mechanisms of the various kinds of attack, formation of a layered structure, surface ablation of steel or matrix attack, and intergranular attack are discussed. The initial alloy oxidation state of the stainless steels, obtained by the formation of a passivating oxide scale, is considered on the basis of the Cr content, constitution diagram, and oxygen partial pressure at the fuel surface. Dissolution of the oxide components at high burnup in the oxygen-containing liquid Cs phase by oxygen exchange reactions gives a reasonable explanation for changes in oxidation rate caused by changes in defect concentration. Scale formation, stress development, breakdown of the oxide layers, and penetration of the oxygen-containing Cs in between the oxide film and the alloy explain the strong increase in corrosion. (8 fig, 105 references)

805 ANALYSIS OF IRRADIATION-INDUCED OXYGEN MIGRATION IN THE L-1 EXPERIMENT. Trotabas, M.; de Keroulas, F.; Gatesoupe, J. P. (CEA, Fontenay-aux-Roses, France). pp 315-324 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

One of the most important factors in the choice of a nuclear fuel is the O/U + Pu ratio, which governs most of the physicochemical properties, such as thermal conductivity, vapor tension, oxygen potential, compatibility with cladding and so on. Rand and Markin have proposed a model in which the oxygen gradient in the fuel under irradiation is controlled by a constant CO/CO_2 or H_2/H_2O ratio within the fuel pin. This model was supplemented by Aitken, who also took oxygen transport in the solid and by the vapor phase above the mixed oxide into account. The purpose of the L-1 irradiation was to analyze the radial redistribution of oxygen resulting from the thermal gradient set up during irradiation and to check the validity of these models. (auth)

806 THERMODIFFUSION AND VAPORIZATION IN IRRADIATED MIXED OXIDES: EVOLUTION OF THE Pu/U + Pu RATIO. Mouchnino, M. (CEA, Fontenay-aux-Roses, France). pp 325-335 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The distribution of the Pu/U + Pu ratio in nuclear fuels is a determining factor for important parameters such as the spatial power distribution and the Doppler coefficient of reactivity. X-ray autofluorescence, a method of spectrographic analysis, makes it possible to measure the Pu/U + Pu ratio in favorable conditions on a large number of oxide samples irradiated in very different conditions. (6 figures) (auth)

807 RELEASE OF FISSION GASES BY URANIUM OXIDE IN FUEL ELEMENTS. Chenebault, P.; Delmas, R. (CEN, Grenoble, France). pp 337-348 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Two groups of methods were used to evaluate the amounts of fission gases released by uranium oxide fuel elements in "light water" and "heavy water–gas" reactors: analysis of the gases released instantaneously during irradiation, and analysis of local concentrations in the irradiated elements. A synthesis of the results obtained in these two ways reveals correlations between the amounts of gas released and the main irradiation parameters: temperature, geometry, and time. (auth)

808 REACTIONS BETWEEN SODIUM AND MIXED OXIDES. Housseau, M.; Dean, G.; Perret, F. (CEA, Fontenay-aux-Roses, France). pp 349-360 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

In order to predict the consequences of 'n-pile cladding failures, reactions between sodium and mixed oxides were studied outside the reactor with various fuels, some irradiated and some not. The possibilities of reaction in the U–Pu–O–Na system were studied some years ago by Aitken on the basis of thermodynamic data relating to (U,Pu)–O and Na–O compounds. The factors involved in these reactions are studied, particularly the effects of oxide composition and sodium purity. (7 tables) (auth)

809 REACTION BEHAVIOR OF FISSION PRODUCTS IN CARBIDES. Holleck, H.; Smailos, E. (Kernforschungszentrum, Karlsruhe, Ger.). pp 361-378 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Phase diagrams of the systems (Th, U, Pu)–fission product–carbon are given. These ternary sections are partially estimated. Investigations of UC with a simulated high burnup (10, 20, 30%) show the occurrence of four different phases as inclusions. (10 figures) (auth)

810 LEAD CENTERS IN ALKALI HALIDES: NaCl, KCl, AND KBr. Sastry, S. B. S.; Viswanathan, V.; Ramasastry, C. (Indian Inst. of Tech., Madras). J. Phys. Soc. Jap.; 35: No. 2, 508-513(Aug 1973).

The optical absorption spectra of x-irradiated lead doped NaCl and KCl crystals taken at room and liquid nitrogen temperatures show a new absorption band at 254 nm and an additional absorption in the 310 nm region. In the case of x-irradiated KBr : Pb crystal a new band at 278 nm is observed. These bands are attributed to Pb^+ centers from optical bleaching and other studies. The structure of the characteristic B band of Pb^{2+} ion observed for the first time in heavily doped KCl : Pb (≈ 500 ppM) is also discussed. (auth)

811 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR THE SOLID TO GASEOUS CONVERSION OF MATERIAL WHICH SUBLIMES. Gillies, G. M.; Littlechild, J. E. (to United Kingdom Atomic Energy Authority). British Patent 1,341,380. 19 Dec 1973. Filed date 11 May 1970. 3p.

The apparatus described is applicable to continuous and automatically controlled operation, and is suitable for the continuous conversion of solid UF_6 into UO_2 by reaction with steam and hydrogen. The apparatus comprises a container for the solid material with a gas outlet and means for spraying hot water over it to cause vaporization. The rate of supply of hot water over the container and therefore the rate of vaporization of the solid is controlled in accordance with the pressure of gas in the container. Preferably the hot water spray is derived by recirculation of water gathered at the base of the container after spraying, the recirculation being effected by a steam ejector that reheats the water, the supply of steam to the ejector, and hence the rate of recirculation of the water, being controlled by the pressure of gas in the container. Means may also be provided for spraying cold water over the container in order to terminate the conversion. (UK)

812 TEPLOFIZICHESKIE SVOISTVA NEMETALLICHESKIKH MATERIALOV (OKISLY). Spravochnaya Kinga. (Thermophysical Properties of Nonmetallic Materials (Oxides). Reference Book). Krzhizhanovskii, R. E.; Shtern, Z. Yu. Leningrad; Energiya Leningradskoe Otdelenie (1973). 336p.

The properties of Al_2O_3, BaO, BeO, vanadium oxides, Ga_2O_3, HfO_2, GeO_2, iron oxides, Y_2O_3, CdO, CaO, CoO, SiO_2, MgO, man-

ganese oxides, copper oxides, NiO, niobium oxides, SnO_2, La_2O_3, cerium oxides, praseodymium oxides, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, SrO, Ta_2O_5, titanium oxides, ThO_2, uranium oxides, Cr_2O_3, ZnO, ZrO_2, Dinas, magnesite, mullite, zircon, chamotte, and spinel were given in tables and graphs. The properties considered were crystal structure, density, thermal decomposition, thermodynamic properties, heat conductivity, electrical properties, optical properties, and interaction with other materials. (JSR)

813 INCREASE IN PARTICLES OF THE STRENGTHENING PHASES IN THE PREPARATION OF DISPERSION-STRENGTHENED ALLOYS. Portnoi, K. I.; Babich, B. N.; Romanovich, I. V.; Romashov, V. M. Fiz. Khim. Obrab. Mater.; No. 6, 99-103 (1973). (In Russian).

X-ray and electron-microscope methods were used in determining the average sizes of particles of the strengthening phase in an alloy of nickel with 3 vol % hafnium dioxide at stages of its preparation from an initial powdered mixture of the oxide up to compact deformed rods. The highest rate increase in particle size occurred during sintering and hot extrusion. The basic cause of enlargement of the particles during the preparation of dispersion-strengthened alloys is the unequal distribution, which allows direct contact of the particles. The electron-microscope method gives more reliable information than does the x-ray method in the determination of average particle sizes in this process. (tr-auth)

814 ORDERING OF HYDROGEN IN β-VANADIUM HYDRIDE NEAR TO V_2H. Cambini, M. (EURATOM, Petten, Netherlands); Serneels, R.; Gevers, R. Phys. Status Solidi (a); 21: No. 2, K57-K59(16 Feb 1974).

Results of studies are reported in which polycrystalline V foils and monocrystalline V were electrolytically charged with H. The quantity of β-V_2H precipitated in the α-matrix was estimated by light microscopy and by x-ray patterns. It is concluded that the V_2H sublattice is slightly monoclinic. H atoms appear likely to occupy octahedral interstices on alternate $(10\bar{1})$ V planes in accordance with the translation symmetry. An expression for the superstructure cell is given. (JRD)

815 INFLUENCE OF THE INTRINSIC THERMISTOR EFFECT OF VO_2 COPLANAR SWITCHING DEVICES. Loeser, W. (Univ., Dresden); Mattheck, C.; Haubenreisser, W. Phys. Status Solidi (a); 21: No. 2, 487-496(16 Feb 1974).

Experimental investigations of the temperature dependence of the electrical conductivity $\sigma(T)$ of VO_2 thin films in coplanar switching devices have shown a thermistor-like behavior of $\sigma(T)$ below the critical temperature $T = T_c$. At T_c the VO_2 material undergoes a structural phase transition of first kind which is connected with a sharp jump in the $\sigma(T)$-curve reaching a constant value σ_2 for $T \geq T_c$. Approximating the measured $\sigma(T)$-curve by $\sigma_1 = \sigma_0 \exp[-\Delta E/k_B T]$ for $T < T_c$ (thermistor effect) and $\sigma_2 = \text{const}$ for $T \geq T_c$ the hitherto neglected influence of the thermistor effect on the static and dynamic switching behavior of a coplanar VO_2 switching device is calculated numerically in dependence on relevant model parameters. Especially, the ambient temperature T_0 is varied and an optimal value of T_0 has been obtained where a minimal time of a switching cycle appears for a fixed parameter constellation. (auth)

816 PROCESS FOR PRODUCING URANIUM DIOXIDE RICH COMPOSITIONS FROM URANIUM HEXAFLUORIDE. Dada, A. G.; De Hollander, W. R. (to General Electric Co.). US Patent 3,796,672. 12 Mar 1974. Filed Date 2 Oct 1970. 16p.

The conversion of gaseous UF_6 to UO_2 rich composition in the presence of an active flame in a reaction zone is achieved by introducing a gaseous reactant comprising a reducing gas and a gaseous reactant comprising a mixture of uranium hexafluoride and an oxygen-containing carrier gas, the reactants being separated by a shielding gas as introduced to the reaction zone. The shielding gas temporarily separates the gaseous reactants and temporarily prevents substantial mixing and reacting of the gaseous reactants. (5 figures) (auth)

817 CHEMICAL AND MECHANICAL PREPARATION OF BeO CRYSTAL SURFACES. Ehman, M. F.; Medellin, D.; Johnson, G. W (Rockwell International, Anaheim, CA). Metallography; 6: No. 6, 473-481(Dec 1973).

The mechanical and chemical techniques required for preparing flat, damage-free BeO surfaces for epitaxial deposition are described. The vibratory polishing techniques result in scratch- and pit-free surfaces when viewed at 230 × with maximum surface damage of 0.16 μm. Chemical etchants are described for evaluating crystal defect density and penetration of surface damage incurred during mechanical preparation. (auth)

818 OXIDATION OF REFRACTORY COMPOUNDS. III. Voitovich, R. F.; Pugach, E. A. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 86-92(Mar 1974). (In Russian).

High-temperature oxidation of group VI metal borides was investigated within a temperatures range of 500 to 1200°C in the air. High resistance of the borides to oxidation is determined by the formation of the fusible oxide B_2O_3 taking part in healing the scale pores and cracks and in the case of CrB_2—also by the formation of phases of borate type. (auth)

819 INVESTIGATION OF ABRASIVE EROSION OF SINTERED TUNGSTEN HARD ALLOYS. Uuzmyis, Kh.; Kleis, I.; Tumanov, V.; Tiidemann, T. Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 98-101(Mar 1974). (In Russian).

Results of the research on erosion of WC–Co alloys are reported. It is established that the erosion rate of WC–Co alloys is dependent upon the size of carbide grains and Co content. At higher impact velocities of abrasive particles (up to 330 m/sec) the relative wear-resistance of WC–Co alloys, as compared with the soft steel St. 3, shows a tendency toward a substantial increase. (auth)

820 CAPACITANCE STUDY OF A METAL–Ta_2O_5–Si STRUCTURE AT LOW FREQUENCY. El Arabi, A.; Seve, G.; Lassabatere, L. (CNRS, Montpellier, France). Thin Solid Films; 21: No. 1, 11-18(Mar 1974). (In French).

The dispersion of the complex permittivity of a thin layer of Ta_2O_5 was studied by measurement of the capacitance and conductance of a metal/Ta_2O_5/Si(p) structure, in inversion, at different temperatures. At frequencies below 2 kHz at 300°K, there are two relaxation processes of the Debye type which are attributed to a distribution of dipoles and to a trapping phenomenon respectively. In the range between 400 Hz and 2 kHz the relaxation time τ obeys an exponential law, $\tau = \tau_0 \exp(E/KT)$, where $\tau_0 = 10^{-15}$ s and $E = 0.71$ eV. At lower frequencies, the accuracy of the measurement is not sufficient for the determination of E and τ_0. A contribution due to space charge was found at frequencies greater than 2 kHz. (8 fig) (auth)

821 TRAPS IN THERMAL Ta_2O_5. Seve, G.; Lassabatere, L. (CNRS, Montpellier, France). Thin Solid Films; 21: No. 1, 19-27(Mar 1974). (In French).

Trapping centers in Ta_2O_5 prepared by thermal oxidation of thin films of sputtered β-Ta were studied. Using the thermally stimulated current method, three peaks were found and their characteristics (density of traps, activation energy, ...) evaluated. (auth)

822 ELASTIC MODULI MEASUREMENTS OF SOME CUBIC TRANSITION METAL CARBIDES AND ALLOYED CARBIDES. Hannink, R. H. J.; Murray, M. J. (Cambridge Univ., Eng.). J. Mater. Sci.; 9: No. 2, 223-228(Feb 1974).

Polycrystalline elastic moduli were determined for TiC, TiC–26% VC, VC–22% TiC, and VC using a composite resonator. Carbon-to-metal ratios were in all cases close to 0.84. Room-temperature moduli variations with alloy composition are discussed and by comparison with other data the order of magnitude of modulus variation with carbon content is determined for TiC. The temperature dependence of Young's modulus for TiC and VC are determined in the range 20 to 1600°C. Correlations are sought with hardness data. (auth)

823 HARDNESS ANISOTROPY IN NIOBIUM CARBIDE. Morgan, G.; Lewis, M. H. (Warwick Univ., Coventry, Eng.). J. Mater. Sci.; 9: No. 3, 349-358(Mar 1974).

Measurements of hardness anisotropy by Knoop diamond indentation on the {100} surfaces of Nb_8C_5 crystals show that the hardness is determined by crystallographic slip on $\{111\}\langle 1\bar{1}0\rangle$ and $\{110\}\langle 1\bar{1}0\rangle$ systems. $\{111\}$ is the preferred slip plane for Nb_8C_5 and crystals with higher carbon content which show a marked decrease in Knoop hardness. The carbon atom/vacancy arrangement in these crystals is shown, by electron diffraction, to possess short-range order. Crystals annealed at low temperatures contain domains of noncubic long-range order which increase the Knoop hardness and eliminate the anisotropy in hardness. Dislocation arrangements around Knoop indentations were directly observed by electron microscopy in an attempt to confirm the slip processes deduced from hardness anisotropy. (auth)

824 PHYSICAL–CHEMICAL ANALYSIS OF CARBIDE PHASES IN ALLOYS OF THE TUNGSTEN–ZIRCONIUM–CARBON SYSTEM. Vedernikova, V. A.; Popov, A. P.; Postnov, L. M. (Inst. of Metal Physics, Kiev). Metallofizika; No. 49, 87-90 (1973). (In Russian).

Thermodynamic calculations are carried out to obtain the temperature dependence for the solubility of carbon in the W–Zr–C system under conditions such that the concentration of zirconium in the alloy is 1 at. %, and to obtain the temperature dependence for the least zirconium concentration necessary for the formation of zirconium carbide in alloys of the W–Zr–C system. From results of a phase analysis of these alloys and the use of literature data, the tungsten corner of the phase diagram is constructed for the W–Zr–C system at 1600°C. These data can be used in

selecting compositions and modes of thermal treatment for high-heat-strength tungsten alloys. (SJR)

825 COMPARATIVE PROPERTIES OF CAST AND SINTERED LANTHANUM HEXABORIDE. Kosyachkov, A. A.; Stepanchuk, A. N.; Shlyuko, V. Ya. (Kiev Polytechnical Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 74-76(Mar 1974). (In Russian).

The processes of lanthanum hexaboride arc melting are described using consumable electrodes under conditions of argon increased pressure in the melting chamber. The results of investigation of melted material characteristics are given. (auth)

826 COMPARISON OF THE V–H AND V–D PHASE DIAGRAMS BY MEANS OF NMR. Arons, R. R.; Bohn, H. G.; Luetgemeier, H. (Kernforschungsanlage, Juelich, Ger.). J. Phys. Chem. Solids; 35: No. 2, 207-214(Feb 1974).

The phase diagrams were investigated by measuring the NMR spectra of vanadium and deuterium in strongly textured vanadium foils. In the cubic α- and α'-phases, both the V and D lines are unsplit. From the orientation dependence of the quadrupole splitting of the two resonances in the tetragonal β-phase, it is found that for both atoms, the electric field gradient is axially symmetric with its largest component parallel to the c-axis. In contrast to V–H, the β-phase of V–D exists only in a small region near D/V ratios of about 0.4 at 300°K; for higher D concentrations, the α'-phase remains stable down to about 200°K, below which the orthorhombic δ-phase is formed. In spite of the nearly cubic arrangement of the V atoms in the δ-phase, the intensity of the vanadium line is reduced corresponding to first-order quadrupole splitting. From the absence of any V satellites in the δ-phase, it follows that the orientation of the principal axes of the field gradient at the V sites deviate strongly from the cube edges of the V lattice. For deuterium the largest component is parallel to one cube edge, which must be the c-axis of the orthorhombic cell. Thus the field gradient at the D sites has the same symmetry in the β and δ-phase, with quadrupole frequencies of 100 and 55 kHz, respectively. This difference can be attributed to the fact that in the two phases different sites are occupied: octahedral sites in the β-phase and tetrahedral sites in the δ-phase. (auth)

827 INTERPRETATION OF MICROCALORIMETRIC MEASUREMENTS OF $h^{M}_{O_2}$ FOR UO_{2+x} OXIDES WITH SMALL DEPARTURES FROM STOICHIOMETRY. Gerdanian, P. (Paris Univ., Orsay, France). J. Phys. Chem. Solids; 35: No. 2, 163-170 (Feb 1974).

The microcalorimetric measurements of $h^{M}_{O_2}$ for UO_{2+x} oxides with small departures from stoichiometry, and experimental values for $g^{M}_{O_2}$ (O/U) are discussed in terms of an oxygen-interstitial, oxygen-vacancy model. (auth)

828 NEUTRON-DIFFRACTION STUDY ON THE STRUCTURAL RELATIONSHIPS OF RCo_5 HYDRIDES. Kuijpers, F. A. (Philips Gloeilampenfabrieken N. V., Eindhoven, Netherlands); Loopstra, B. O. J. Phys. Chem. Solids; 35: No. 3, 301-306 (Mar 1974).

The hexagonal RCo_5 compounds form several orthorhombic hydrides which are structurally closely related. A neutron-diffraction study of β^{I}, β^{II}, and β^{III} types, as found for e.g., $PrCo_5D_{3.4}$, $PrCo_5D_{2.9}$, and $CeCo_5D_{2.55}$ respectively, revealed that the deuterium atoms occupy both octahedral and tetrahedral interstices. In the simplest of these, β^{I}, the occupancy of the interstices is equal; its space group is Cmmm. In both β^{II} and β^{III}, the c-axis is doubled compared with β^{I}. In β^{II}, space group Im2m, the octahedral positions have a uniformly reduced occupancy, which leads to appreciable ordered shifts of the metal atoms. In β^{III} (Cccm), half of the octahedral positions are vacant, giving a limiting stoichiometric composition $CeCo_5H_5$. The magnetizations of the (ferromagnetic) hydrides decrease with increasing hydrogen content. Results of neutron-diffraction analysis are in fair agreement with the magnetization measurements. (auth)

829 THERMAL CONDUCTIVITY OF $UC_{1-x}N_x$ FROM 100 TO 1000°K. Kamimoto, M.; Takahashi, Y.; Mukaibo, T. (Tokyo Univ.). J. Phys. Chem. Solids; 35: No. 3, 393-399(Mar 1974).

The thermal diffusivities of $UC_{1-x}N_x$ of several compositions were measured from 100 to 1000°K by a laser flash method. The thermal conductivity was separated into electronic and phonon components by assuming a constant Lorenz number. The phonon conductivity showed an anomalous behavior against composition at low temperatures. The total thermal conductivity of $UC_{1-x}N_x$ showed a minimum above 300°K at an intermediate composition which moved to higher carbon content with increasing temperature. This behavior was explained by the temperature dependence of the lattice and electronic components. (auth)

830 VANADATES WITH A DEFECT GARNET STRUCTURE. Ronniger, G.; Mill', B.V. (M. V., Lomonosov Moscow State University). Sov. Phys.–Crystallogr. 18: No. 2, 187-190 (Sept 1973).

In MO–$M'O$–V_2O_5 systems, ranges corresponding to the formation of defect garnets with the general formula $\square_{0.5}\cdot(M,M')_{4.5}{}^{2+}V_3{}^{5+}O_{12}$, where M=Pb or Ca, and M'=Mg, Co, Ni, Zn, Mn, or Cd, and garnets $Pb_{3-x}Cd_{2.33+x}V_{2.67}O_{12}$ containing Cd^{2+} ions in four-fold coordination, have been detected. It has been shown that the cation vacancies in V garnets may occupy the c and a positions, with a preference for the former, and do not enter the d positions in significant quantities. (auth)

831 OMEGA-PHASE STABILITY IN THE Ti–Zr–O SYSTEM. Ageev, N. V.; Model, M. S. pp 72-76 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

X-radiographic and microstructure studies of the alloys in the Ti–Zr–O system with constant O concentration at ~25 at. % showed that in the region from 10 to 70 at. % Zr, the $\beta \rightarrow \alpha$ conversion is suppressed at the stage of formation of the ω phase. In the cast state and after annealing in the temperature interval from 1300 to 450°, the ω phase is isolated in the region from 25 to 40 at. % Zr and forms two-phase systems with the adjacent Ti-based and Zr-based solid solutions. The β state in the alloys studied is fixed by rapid quenching. The ω phase is formed at all conditions studied and does not undergo changes during extended low-temperature annealing (450° for 1000 h). This indicates stability of the ω phase. (tr-auth)

832 IRRADIATION OF GEMSTONES. Mumme, I. A. Aust. Gemmol.; 11: No. 11, 7-10(Aug 1973).

The process of artificially inducing colors in gemstones by irradiation is reviewed. The older techniques of irradiation are described and compared with the modern techniques of neutron bombardment and gamma irradiation. The cause of coloring induced by irradiation techniques is discussed. (AT)

Metals and Alloys

Refer also to abstracts 2323, 2364, and 2378.

833 (CONF-720468-) SIXTH ANNUAL INFORMATION MEETING ON HEAVY SECTION STEEL TECHNOLOGY PROGRAM, OAK RIDGE, TENNESSEE, APRIL 25–26, 1972. (Oak Ridge National Lab., Tenn. (USA)). 1972. 452p. Dep. NTIS $24.75.

Twenty-six papers were presented at the HSST meeting. Separate abstracts were prepared for 21 of the papers; one of the remaining papers was previously abstracted as NSA 28: 29788. (DLC)

For abstracts of individual papers see: 252–254, 849, 858–864, 932–934, 2066, 2067, and 2114–2118.

834 (STI/PUB-21-42) RADIOACTIVE TRACERS IN METALLURGICAL RESEARCH. (International Atomic Energy Agency, Vienna (Austria)). 1974. 146p. IAEA $7.00.

In this bibliography, about 756 citations, most with abstracts, are arranged under the following headings: general information (reviews, methods); iron production (charge preparation, pig-iron in blast furnace, steelmaking); nonferrous metal production; treatment of metals (casting, ingots, plastic working); non-metallic inclusions; physical metallurgy; diffusion studies; and various investigations. An author index is included. (DLC)

835 MILIBDEN. (Molybdenum). Zelikman, A. N. Moscow; Izdatel'stvo Metallurgiya (1970). 440p.

The physical and chemical principles and practices in the production of Mo and its important compounds (oxides, chlorides, sulfides, silicides, borides, and carbonyls) are examined. Special attention is given to new trends in the hydrometallurgy of Mo and the production of the compact metal by powder metallurgy and fusion methods. The properties of Mo and the range of its uses are examined. An extensive bibliography is appended. (tr-auth)

Corrosion and Erosion

Refer also to abstract 2139.

836 (FRNC-R-34) CAUSTIC CORROSION TESTS ON STEEL (10CD 9-10) TUBES FOR THE STEAM GENERATORS OF SODIUM COOLED FAST REACTORS. Examination of 3B and 13B Test Pieces. Lecante, A. (Electricite de France, 77–Ecuelles. Dept. Etudes des Materiaux). 17 Nov 1972. 10p. (In French). Dep. NTIS (U. S. Sales Only) $4.00.

Micrographic examinations effected after caustic corrosion tests on two fatigue-cracked tube sections are presented. The 3B test piece having a helium flow of the order of 10^{-1} l μsec under opera-

tional conditions did not show any corrosion effects after 1500 h testing in the presence of sodium and water at 350°C. The 13B test piece, which had a leak rate 10^5 times higher, exhibited considerable corrosion after 40 h testing in the presence of sodium and steam at 450°C. (FR)

837 (RT/CHI-(73)7) EVALUATION OF THE SUSCEPTIBILITY OF DIFFERENT STEELS TO CREVICE CORROSION. Borello, A.; Conte, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 29 Aug 1973. 34p. Dep. NTIS (U. S. Sales Only) $4.75.

A method to evaluate on accelerated basis, on laboratory scale, the susceptibility to crevice corrosion of various alloys was developed. Results on different austenitic and martensitic steels to be used for the CIRENE refuelling machine are reported. (6 tables, 16 figures) (auth)

838 MICROSTRUCTURE FORMATION WITH INTERNAL OXIDATION OF BINARY NICKEL ALLOYS. Alen'kin, V. I.; Kulikov, V. A.; Zaitseva, N. M. pp 229-236 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The effects of oxidizing additives were examined along with the effects of their concentration and temperature on the parameters of microstructures formed during internal oxidation of the binary nickel alloys Ni–Nb, Ni–Al, Ni–Sc, Ni–La, Ni–Ce, Ni–Nd, and Ni–Pr. In addition, results are given on an electronmicroscopic study of the microstructure formation kinetics with internal oxidation of the alloys: Ni–Sc, Ni–Nd, and Ni–Ti. Foils 0.1 mm thick were made from the alloys homogenized at 1200°C in vacuum. Oxidation temperature was 1000°C. The temperature of the oxidizing mixture was 850°C. The oxidation time was varied from 2 min to 10 h. After oxidation all samples were subjected to simultaneous electropolishing to a depth which penetrated the oxidation front in the sample. The electronmicroscopic study showed that the main parameters of the microstructure—number of particles per unit volume, average particle size, and particle size distribution—changed regularly with the change in energy of oxide formation of the alloying element. For example, at an oxidizing temperature of 1200°C, an oxidizing mixture temperature of 950°C and an oxidation time of 3 h, the average particle size at the lowest energy of oxide formation (Ni–Nb) is greater than in an alloy with a high energy of oxide formation (Ni–Pr or Ni–Nd). A smaller energy of oxide formation also corresponds to a smaller number of particles per unit volume. The main oxidation steps are: 1) saturation of the alloy matrix with oxygen and the formation of a metastable phase, 2) breakdown of the metastable phase into discrete particles, and 3) a period of stabilization of the microstructure that is formed. (SJR)

839 MECHANISM OF LOW-TEMPERATURE INTERGRANULAR DESTRUCTION OF WELDED JOINTS OF MOLYBDENUM ALLOYS. Levtova, K. A.; Chernyshova, T. A. Fiz. Khim. Obrab. Mater.; No. 6, 81-84(1973). (In Russian).

The structure and surface destruction of welded joints of molybdenum alloys (Mo–V–C) were studied using an electron microscope. Particles of the second phase were identified by microdiffraction, extraction replication of sample sections, and fractures. The plasticity of welded joints was shown to be closely related to the shape of the grain boundaries and the nature of the intergranular deformation. (tr-auth)

840 INTERACTION OF HYDROGEN WITH A NIOBIUM (100) SURFACE. Hagen, D. I. Pullman, WA; Washington State Univ. (1973). 79p. University Microfilms Order No. 74-4104. Thesis (Ph. D.).

Sorption of H by a Nb (100) surface was investigated by measurements of work function changes, using the Kelvin probe vibrating capacitor method, and H uptake was investigated by the thermal desorption method. H was found to adsorb readily on the surface and to diffuse into the bulk over the entire temperature range studied (90 to 300°K). At 90°K, adsorption on the surface takes place sequentially into three states. The first state, which appears to be molecular and precursor to the second state, is characterized by a dipole moment of –0.022 Debye/molecule, an initial sticking coefficient of 0.23, and a saturation coverage of 3.2×10^{14} molecules/cm^2. The second state is characterized by a dipole moment of –0.141 Debye/atom, a saturation coverage of 9×10^{14} atoms/cm^2, and is similar to the β_1 state for hydrogen on the tungsten (100) surface. The third state, which may adsorb as atoms, appears to be the precursor state for diffusion into the bulk and is estimated to have a saturation coverage of 4×10^{14} atoms/cm^2. Application of the Clausius–Clapeyron equation to isotherms of adsorbate concentration versus dissolved H concentration yields a value of 26.5 ± 3 kcal/mole for the heat of adsorption of hydrogen atoms in state 2. (Diss. Abstr. Int., B)

841 CORROSION PRODUCT DEPOSITION IN MOLTEN FLUORIDE SALT SYSTEMS. Koger, J. W. (Oak Ridge National Lab., TN). Corrosion; 30: No. 4, 125-130(Apr 1974).

Hastelloy N (Ni-16% Mo-7% Cr-5% Fe) is quite compatible with pure fluoride salts and corrosion is difficult to detect. However, when impurities are present, both metal fluoride and metal corrosion products may deposit as the result of the interaction of molten fluoride salts and alloys in a temperature gradient system. Both types of deposits have been studied as they have occurred in iron base and nickel base thermal convection loops operating in the range 460 to 605°C. In the iron base loop, metal deposits, consisting mainly of iron, resulted from extreme changes in the equilibrium constant of the corrosion reaction due to changes in temperature and from the highly oxidizing conditions of the salt. Metal-fluoride deposits also caused plugging in both the iron base and a nickel base loop and were mainly chromium fluorides. These were precipitated from the saturated salt. Under steady state (low corrosion rate) conditions, more of the least stable fluoride corrosion products (such as iron and nickel) deposited than the more stable chromium fluorides. The amount of deposition in the cold leg was a function of the overall corrosion rate and varied only a small amount with temperature. Examination of the steady state deposits with the scanning electron microscope showed several interesting features including possible growth steps with cubic symmetry. (auth)

842 ELECTRIC EROSION RESISTANCE OF COMPOSITIONS ON THE REFRACTORY METAL BASE. Lemeshko, A. M.; Minakova, R. V.; Teodorovich, O. K. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 70-73(Mar 1974). (In Russian).

Research devoted to finding the ways for increasing electric erosion resistance of composite materials with tungsten and molybdenum base and used for the electrodes in electric-spark treatment of metals is described. It is shown that under conditions of the impulse discharge effect for the treating electrode, the rational principles put into the composite materials with a heterogenic structure are realized completely. The value of these materials wearing under the effect of the impulse discharge depends on the strength of the refractory phase frame. That is why the materials used for the treating electrodes should be subjected to heat treatment ensuring an increase in the refractory frame strength or should contain alloying additives promoting the strength increase. (auth)

843 BORONIZATION OF Mo AND Nb. Sosnovskii, L. A.; Epik, A. P.; Tverdokhleb, V. S. (Inst. of Problems in Materials Science, Kiev). Zashch. Pokrytiya Metal.; No. 7, 73-77(1973). (In Russian).

The dependence of the thickness of the boride coating on Mo and Nb on the chemical components of the activating additive used in the boronization was studied. The possibility was shown of using a highly active mixture containing amorphous boron. It was established that the phase composition and the thickness of the boride coating on the molybdenum are determined by the activity of the boronizing medium used. (tr-auth)

844 BORONIZATION OF STEEL AND CAST IRON WITH COMMERCIAL BORON CARBIDE. Loskutov, V. F.; Permyakov, V. G.; Pisarenko, V. N.; Trush, I. Kh.; Yakovchuk, Yu. E.; Amirkhanova, T. V. (Inst. of Problems in Materials Science, Kiev). Zashch. Pokrytiya Metal.; No. 7, 77-79(1973). (In Russian).

The kinetics of the increase in the diffusion layers upon saturation of steel and cast iron with commercial boron carbide was studied. The effect of strong carbide-forming elements (Zr, V, Ti, Nb, W, and Cr) on the kinetics of the increase in the carbide layers was determined. The optimum temperature of boronization for carbon steels was found to be 900-950°C and for cast irons, 950-1000°C. (tr-auth)

845 MODIFIED DIFFUSION SILICIDE COATINGS FOR PROTECTION OF Mo FROM OXIDATION. Byalobzheskii, A. B.; Krasilov, B. I.; Tsirlin, M. S. (Inst. of Physical Chemistry, Moscow). Zashch. Pokrytiya Metal.; No. 7, 90-94(1973). (In Russian).

Results are reported of studies on silicide coatings on molybdenum and the alloy TsM-2A, modified with boron and manganese. The mechanism of oxidation of the coating in air at 1300-1500°C was studied. It was shown that alloying of silicide coatings with boron and manganese increases the service life of the coating 4- to 5-fold. A method was developed for obtaining boro-silicide coatings which ensures formation of a layer of Mo_5SiB_2, an effective anti-diffusion barrier for silicon. A 10- to 15-fold increase in the service life of such coatings at 1500°C over that of a simple silicide coating was demonstrated. (tr-auth)

846 DIFFUSION SATURATION OF STEEL WITH Ti, Ni, AND W. Mudrova, A. G.; Gorbunov, N. S. (Murmansk Higher Marine Engineering School, USSR). Zashch. Pokrytiya Metal.; No. 7, 142-144(1973). (In Russian).

Results of studies on the process of complex saturation of steel with Ti, Ni, and W and the effect of the process on microhardness and resistance to hydro-erosion are reported. It was established that the thickness of the zone with a high concentration of the elements was 200 to 400 μ with a total depth of the layer of 1.0 to 1.5 mm. It was shown that the diffusion layer has a high surface hardness (3700 kg/mm^2) and resists destruction by hydro-erosion. (tr-auth)

847 REACTION OF BORIDE COATINGS ON MOLYBDENUM AND TUNGSTEN WITH CARBON. Evtushok, T. M.; Zhunkovskii, G. L. (Inst. of Problems in Materials Science, Kiev). Zashch. Pokrytiya Metal.; No. 7, 192-195(1973). (In Russian).

The possibility of using diffusing boride layers on Mo and W as "barriers" against carbonization of the latter was investigated, and the temperature limits of stability of the boride layers in contact with different carbon-containing media were established. It was shown that, during annealing, the phase composition of the boride layers changes and instabilities appear relative to the carbon of the lowest boride phase; the formation and rate of increase of these determine the start and the rate of the process of interaction of the boride "barrier" layer with the carbon-containing medium. It is shown that the stability of the boride "barrier" layers depends on the physical state of the contacting substances and the medium in which the interaction occurs. (tr-auth)

848 AUGER SPECTROSCOPY OF URANIUM. Allen, G. C.; Wild, R. K. (Central Electricity Generating Board, Berkeley, Eng.). J. Chem. Soc., Dalton Trans.; No. 5, 493-498(1974).

Uranium metal and oxidized uranium metal surfaces were examined by use of Auger electron spectroscopy. The methods used to obtain clean and oxide-free uranium metal surfaces are discussed together with the changes in the Auger spectra on oxidation. Chemical shifts in the uranium Auger peak positions resulting from changes in the electron energy levels in neutral uranium and uranium(IV) were predicted by use of the electron binding energies determined by x-ray photoelectron spectroscopy. (auth)

Preparation and Fabrication

Refer also to abstracts 282 and 2132.

849 (CONF-720468-, pp vp Paper 18) FABRICATION HISTORY OF THE HSST INTERMEDIATE TEST VESSELS. Childress, C. E. (Oak Ridge National Lab., TN). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The HSST program has among its objectives the demonstration of the capability to predict failure of flawed, heavy-wall pressure vessels under frangible, transitional, and tough loading regimes. A series of tests, intermediate between conventional laboratory tests and a full-scale vessel, have been planned to permit characterization of the many parameters that influence fracture in an actual pressure vessel. Six 6-in.-thick vessels have been fabricated initially from A508 class 2 forging materials to conduct these intermediate tests. The fabrication history and the final test results for the first two vessels are presented. (auth)

850 (JUL-1011-RW) WELDED JOINTS BETWEEN DIFFERENT MATERIALS, ILLUSTRATED BY THE EXAMPLE OF MATERIAL COMBINATIONS OF INTEREST IN NUCLEAR SCIENCE AND TECHNOLOGY. Metzger, G.; Lison, R. (Kernforschungsanlage Juelich G.m.b.H. (F. R. Germany). Inst. fuer Reaktorwerkstoffe). Oct 1973. 124p. (In German). Dep. NTIS (U. S. Sales Only) $8.25.

An account is given of examinations of 33 combinations of two different materials, one combination of three, and one combination of four different materials. The data showing the hardness, microstructure, and alloying behavior of filler metal mixtures of some materials combinations welded together were obtained on samples fused in an electric arc furnace. The information gained from these data for the prediction of the weldability of a given materials combination proved to be useful in only a few of the cases examined, owing to quick cooling of the filler metal and the formation of brittle phases between filler metal and the material to be welded. All welded joints were carried out as butt welds in sheets of 2 or 3 mm thickness. The materials used include silver, aluminium, copper, copper–nickel alloys (Cu20Ni), chromium–nickel austenitic steel (Fe18Cr8Ni), niobium, nickel, nickel–chromium–iron alloys (Ni15Cr7Fe), titanium, vanadium, vanadium–titanium alloys (V10Ti), and a zirconium alloy (Zr2Sn). The welded joints were examined by metallographic methods, tensile stress tests, and bending stress tests. (34 figures, 17 tables) (GE)

851 TEMPERATURE DEPENDENCE OF THE FORMATION OF SOLID SOLUTIONS IN SINTERING OF POWDER EXTRUSIONS OF V–Mo. Aleshina, L. A.; Vrublevskaya, E. L.; Mokrov, A. P.; Rykova, L. L.; Shivrin, O. N.; Rabinovich, E. M. Fiz. Khim. Obrab. Mater.; No. 6, 111-117(1973). (In Russian).

The effect of different sintering regimes on formation of a V–Mo solid solution was studied. The minimum time was established for holding the preparation at different temperatures for formation of the solid solution. (tr-auth)

852 STUDY OF DIFFERENT TONES OF WELDED Mo JOINTS BY INTERNAL-FRICTION AND ELECTRON-MICROSCOPE METHODS. Malan'in, Yu. M.; Kaverina, S. N.; Rzhevskaya, I. Ya.; Shulepov, V. I.; Yudkovskii, S. I. Fiz. Khim. Obrab. Mater.; No. 6, 123-126(1973). (In Russian).

It was shown to be highly probable that the origin of friction in the zone around the seam of a welded Mo joint is related to the disappearance of the cellular structure of the metal during the welding owing to a sharp drop in the solubility of the impurities introduced, and to precipitation of carbide particles, around which there is considerable local phase cold hardening. (tr-auth)

853 AUTOMATIC ULTRASONIC CONTROL OF TUNGSTEN AND MOLYBDENUM MOLDINGS. Yagofarov, V. Kh. Tsvetn. Metal.; No. 1, 78-79(Jan 1974). (In Russian).

A sketch is presented of equipment which was developed for control of the quality of molded tungsten and molybdenum parts and increase the possibilities and sensitivity of ultrasonic defectoscopy and thus increase capacity and improve control of production. (tr-auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 254, 450, 1939, 2067, 2114, 2121, 2360, and 2362.

854 (AD-769734) INVESTIGATION OF THE EQUILIBRIUM ALPHA AND BETA PHASES IN THE ALLOY Ti–6Al–4V. Final Report. Fopiano, P. J.; Comerford, M. F. (Army Materials and Mechanics Research Center, Watertown, Mass. (USA)). Oct 1973. 14p. (AMMRC-TR-73-44). NTIS $2.75.

Specimens of Ti-6Al-4V alloy were heat treated to produce several equilibrium compositions of the alpha and beta phases whose minimum dimensions were 10 microns. The phases were analyzed with an electron microprobe analyzer and their compositions were evaluated based on a microprobe analysis of standard compositions made up of the major alloying elements. The vanadium partitioned preferentially to the beta phase while the aluminum partitioned preferentially to the alpha phase, but not to the extent expected. The results are correlated with the published literature. Selected compositions of the alpha and beta phases were synthesized. The results of aging studies on the single phases are compared with the composite alloy. (auth)

855 (ANL-8002) BILINEAR REPRESENTATIONS OF THE CYCLIC STRESS-STRAIN BEHAVIOR OF TYPES 304 AND 316 STAINLESS STEEL FROM 800 TO 1200°F. Cheng, C. F.; Cheng, C. Y. (Argonne National Lab., Ill. (USA)). Feb 1974. Contract W-31-109-eng-38. 18p. AT.

Bilinear representations of the elastic–plastic strain-hardening behavior of Types 304 and 316 stainless steel under cyclic loading conditions between 800 and 1200°F and a strain rate of 4×10^{-3} s^{-1} were determined. Effects of maximum strain, temperature, heat treatment, and tension hold time on bilinear hardening functions and coefficients were evaluated. At or below 0.25% maximum strain ($\epsilon_{max} = \Delta\epsilon_t/2$), κ_s^h values of 1.0 and 1.5×10^4 psi are recommended for Types 304 and 316 stainless steel, respectively. (10 figures, 4 tables) (auth)

856 (BNL-18726) INELASTIC NEUTRON SCATTERING FROM AMORPHOUS GERMANIUM. Axe, J. D.; Keating, D. T.; Cargill, G. S. III; Alben, R. (Brookhaven National Lab., Upton, N. Y. (USA); Yale Univ., New Haven, Conn. (USA)). 1974. 4p. (CONF-740313-3). Dep. NTIS $4.00.

From international conference on tetrahedrally bonded amorphous semiconductors; Yorktown Heights, New York, USA (20 Mar 1974).

Inelastic neutron scattering was used to study vibrational spectra of amorphous germanium. The incoherent limit neutron scattering method was used. Preliminary results with a 5-gram sample of evaporated amorphous germanium indicate that the lowest energy peak in the density of states is broadened, and

its center of gravity is shifted to somewhat lower energy than the corresponding TA phonon peak in the crystalline density of states. (DLC)

857 (CEA-CONF-2512) EXPERIMENTAL METHOD FOR THE STUDY OF THE DISLOCATION LOOP NUCLEUS: DETERMINATION OF ITS SIZE. Leteurtre, J.; Pouchou, J. L.; Zuppiroli, L.; Bounaud, J. Y. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). 1973. 11p. (In French). (CONF-730669-2). Dep. NTIS (U. S. Sales Only) $3.00.

From metallurgy colloquium: the phenomena of precipitation and their consequences on the properties of metallic alloys; Saclay, France (25 Jun 1973).

The principles of the method are described. The basic experience on which this method rests is the measurement of the dimensional variations of a monocrystalline sample irradiated under uniaxial stress. By favoring certain Burgers vectors to the detriment of others, the stress creates an absence of equilibrium in the loop populations. The anisotropy thus introduced is bound exclusively to the germination of dislocation loops. It is shown that the induced growth coefficient which measures this anisotropy depends directly on the size of the nuclei of lacunar and interstitial loops. The statistical hypothesis leading to this result is discussed. Typical experimental results are given for U, W, Mo, and Cu. (tr-auth)

858 (CONF-720468-, pp vp Paper 6) FATIGUE CRACK PROPAGATION BEHAVIOR OF ASTM A533B AND A302B STEELS IN HIGH TEMPERATURE AQUEOUS ENVIRONMENT. Kondo, T.; Kikuyama, T.; Nakajima, H.; Shindo, M. (Japan Atomic Energy Research Inst., Tokai). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The materials included HSST A533-B and the Japanese domestic A533-B and A302-B materials. Effect of some mechano-chemical factors on the mode of crack growth was surveyed. The dependence of the rate of crack propagation, da/dN, on the stress intensity factory range, ΔK_I, was also examined for different loading conditions. Rate of crack growth per given set of loading cycles was influenced by the stress wave pattern, loading frequency, and the crack geometry. The occurrence of the incubation of propagation (i.e., crack blunting), characteristic in low-frequency tests in the aqueous environment, was limited to some particular test conditions. Studies of these occurrences confirmed the hypothesis that the formation of macroscopic corrosion pits formed at the tips of growing cracks is responsible for the phenomenon. A comparison of crack growth in the aqueous environment relative to that in ambient air for each test run showed substantial differences; however, da/dN vs ΔK_I curves for the two environmental conditions as obtained under load-controlled, tension-to-tension conditions gave good agreement. (13 figures) (auth)

859 (CONF-720468-, pp vp Paper 7) CRACK GROWTH INVESTIGATIONS ON 22 NiMoCr 37 AT ROOM TEMPERATURE AND 300°C. Gerscha, A.; Klausnitzer, E. (Siemens AG, Erlangen, Ger.). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Crack growth in air was studied, and the influence of various parameters such as testing temperature, heat treatment, and size of forgings on crack growth rate was determined. The investigations were carried out on WOL, CT, and three-point bending test specimens. Crack growth was detected both visually and ultrasonically. Using the correlations of da/dn to $(\Delta K)^n$, three zones with different crack growth exponents were found. The largest exponent zone initiated as the loading condition for the specimen changes from plane strain to plane stress. At this point the influence of the plastic zone becomes noticeable. As the linearly calculated stress exceeds about double the yield point, the exponent increases rapidly. The following parameters were not found to have a large effect on the crack growth rate: 1. testing temperature: room temperature or 300°C; 2. thickness of the forged ring: 80 or 280 mm; 3. location of the specimen: center or surface of a 280-mm-thick forged ring; and 4. additional heat treatment: an 80-mm-thick forged ring, which has been tempered and stress-relieved at 570°C, was subjected to another three heat treatments at 550–610°C for 2 h each. Tests of crack growth rate on ASTM A533-B class 1 steel gave good agreement with the 22 NiMoCr 37 steel, although the latter differs slightly in its Cr, Ni, and Mn contents. (10 figures) (auth)

860 (CONF-720468-, pp vp Paper 8) DEVELOPMENT OF ELECTRON-BEAM-WELDED CT SPECIMENS FOR FRACTURE TOUGHNESS MEASUREMENTS WITH A SMALL AMOUNT OF ORIGINAL MATERIAL. Klausnitzer, E.; Gerscha, A. (Siemens AG, Erlangen, Ger.). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Large test specimens are required for measurements of K_{Ic} on steels with a high fracture toughness (for instance 22 NiMoCr 37, ASTM A533, grade B, class 1). However, it is impossible in many instances to take large specimens from the forgings or plates. This size problem is particularly serious in the investigation of K_{Ic} gradients over the wall thicknesses or in heat-affected zones. A composite test specimen was therefore developed for which only a small portion of the original material is required, while the rest is an auxiliary material with similar properties. The two parts of the test specimen are joined by electron-beam welding. The composite test specimen has the same dimensions as the CT specimens of ASTM E 399. Both 1 T and 2 T composite test specimens of 22 NiMoCr 37 with various proportions of original material were tested. Investigations emphasized the question as to whether stress-relieving should be required after welding. Results of these investigations of the composite CT specimens are compared with test results from conventional CT specimens, and technical details are discussed. (7 figures) (auth)

861 (CONF-720468-, pp vp Paper 10) CRACK ARREST STUDIES. Ripling, E. J.; Crosley, P. B. (Materials Research Lab., Glenwood, IL). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

In order to determine whether the crack arrest toughness, K_{Ia}, measured with a contoured DCB specimen identifies the condition for crack arrest in a specimen or structure where the stress intensity factor increases with crack length, fracture toughness tests were made on single-edge-notch tension specimens. An electron beam weld was used to provide a brittle region for initiating a crack. To initiate fracture; the EB weld was charged with hydrogen while the specimen was under load. With high applied loads, the cracks ran completely across the specimen. With low loads, the cracks ran through the brittle weld but arrested at the base plate. In cases where crack arrest occurred, the value of the stress intensity factor for a crack with a depth equal to the brittle weld depth was less than the crack arrest toughness K_{Ia} measured on contoured DCB specimens. In the cases where the crack ran completely across the specimen the stress intensity factor was greater than K_{Ia}. (auth)

862 (CONF-720468-, pp vp Paper 11) EFFECTS OF STRAIN GRADIENTS ON THE GROSS STRAIN CRACK TOLERANCE OF A533B STEEL. Randall, P. N. (TRW Systems, Redondo Beach, CA). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

At stress levels above yield, a useful measure of the fracture toughness of A533-B steel can be given in terms of its tolerance for strain in the presence of a crack. The effects of strain gradients (both axial and transverse) were studied, because they represent a common difference between test and application. Transverse gradients in the direction of the crack-tip depth were produced by the use of bend specimens of three different depths. Actually, the specimen proper had the same cross section in every case. The deeper beams were made by welding on a backup bar. In a fourth series, the cracked face was placed against the backup bar. Axial-plus-transverse gradients were produced by locating the crack in a groove machined across the face of the specimen. Some were loaded in tension, some in bending. The principal findings are a better understanding of the transition temperature, which was found in tension tests to coincide with the temperature at which gross section yielding precedes fracture. The critical gross strain is believed to be that at the depth where fracture originates around the crack border. The transition in strain values with rising temperature began at about the same temperature in all cases, but it was much more gradual in the presence of a strain field that decreased in the direction of crack advance across the thickness, and vice versa. The physical picture that fits these observations is as follows. Enhancement of the local, crack-tip ductility through relief of constraint requires the development of a wedge-shaped plastic zone extending from the crack tip to the back face free surface. Strain gradients that inhibit development of the zone are detrimental to gross strain crack tolerance at gross stress levels beyond yield, and vice versa. (23 figures) (auth)

863 (CONF-720468-, pp vp Paper 14) TESTING OF ONE-INCH-THICK AND SIX-INCH-THICK FLAWED TENSILE SPECIMENS. Grigory, S. C. (Southwest Research Inst., San Antonio). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The fifteen million pound capacity tensile test facility at Southwest Research Institute has been used to test a series of large tensile specimens for the HSST program. These specimens are A533, grade B, class 1, and are 6 in. thick, 18 in. wide, 4 ft long, and contain flaws. Thirteen tests at temperatures from 50 to 220°F and requiring loads up to 7.5 million pounds for failure have been conducted. Seven longitudinal specimens were tested at temperatures of 50, 75, 100 (three each), and 220°F (two each). Three transverse specimens have been tested at 100, 130, and 220°F, and three welded specimens have been tested at 0, 75, and 160°F. In addition, a series of 1-in.-thick flawed tensile specimens have been tested as part of a size effect study. A total of twenty-two 1-in. specimens, including six transverse specimens, have been tested over the temperature range 0 to 200°F. (auth)

864 (CONF-720468-, pp vp Paper 23) EXPERIMENTAL VERIFICATION OF LOWER BOUND K_{Ic} VALUES UTILIZING THE EQUIVALENT ENERGY CONCEPT. Mager, T. R. (Westinghouse Nuclear Energy Systems, Pittsburgh). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Compact tension (CT) specimens were tested from −50 to 550°F and the results analyzed using equivalent energy concepts. This method utilizes a fracture resistance toughness K_{Icd} value which has been postulated to be a lower bound for K_{Ic}. This paper presents K_{Icd} values generated for A533, grade B, class 1 steel plate and NiCrMoV rotor forging grade material. The testing utilized compact tension specimens from 1 in. thick (1 T CT) up to 9 in. thick (9 T CT). Results indicate that K_{Icd} is a lower bound K_{Ic} value. Included in the paper is a brief description of an experiment to demonstrate the validity of calculating K_{Icd} values from test results where the clip gage length and elevation are constant for all specimen sizes. Results of this experiment demonstrate that there is no distinguishable variation or trend which can be attributed to increasing the clip gage length and elevation with specimen size. (7 figures) (auth)

865 (COO-2212-2) STUDY OF DISLOCATION DYNAMICS ASSOCIATED WITH DUCTILE–BRITTLE TRANSITION AND HYDROGEN EMBRITTLEMENT PHENOMENA OBSERVED IN BCC METALS. Annual Technical Progress Report II. Gerberich, W. W.; Atteridge, D. G. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). Mar 1974. Contract AT(11-1)-2212. 220p. Dep. NTIS $14.00.

Laboratory setups for acoustic emission and stress-wave emission capabilities allows the recording of dislocation and cracking events. Stress relaxation, dynamic loading, load drop, crack-opening displacement, and other detailed flow and fracture tests can be run. Environmental setups include low-temperature and gaseous environment capabilities. Theoretical and experimental analysis were carried out of both stress-intensity threshold and crack growth rate which are conditions for hydrogen-assisted cracking. Several test programs have evolved which should resolve the role of both the stress field and the long-range diffusion of hydrogen in the embrittlement process. The ability to associate a single stress-wave emission with a single discontinuous fracture event of finite area was developed, enabling in-situ studies of such growth processes. For studying the ductile–brittle transition, all test specimens were prepared and readied for testing except for pre-fatigue cracking of some fracture toughness specimens. Results are given on the ductile–brittle fracture transition in Fe-base alloys. (DLC)

866 (COO-3331-6) ULTRASONIC ATTENUATION STUDIES OF THE ELECTRONIC STRUCTURE OF METALS. Progress Report, June 1, 1973–May 31, 1974. Hoffman, A. R. (Massachusetts Univ., Amherst (USA)). 1974. Contract AT(11-1)-3331. 9p. Dep. NTIS $4.00.

Measurement of the thermal conductivity (K) in two Be samples is proceeding. K has been accurately measured in the purer sample (residual resistivity ratio ~2000) from 1.5 to 40°K and the expected maximum in K variation with temperature was observed at 36°K. Preliminary measurements of K as a function of magnetic fields up to 65 kOe were made at several temperatures ranging from 4 to 14°K. (auth)

867 (HSSTP-TR-34) INVESTIGATION OF MODE III CRACK EXTENSION IN REACTOR PIPING. Final Report. Podlasek, R. J.; Eiber, R. J. (Battelle Columbus Labs., Ohio (USA)). 14 Dec 1973. Subcontract 3678. 23p. Dep. NTIS $4.25.

For Oak Ridge National Lab., Tenn.

The objective was to examine the conditions required for a propagating Mode III tearing shear fracture (propagation by spiralling around pipe) in nuclear reactor piping. Five experiments using A106B carbon steel were conducted in which the parameters of saturation pressure, defect length, and stored energy were varied. One experiment, Experiment 39, was identical to Experiment 32 of the previous study in which a propagating Mode III tearing shear fracture was observed. In all five experiments, no extensive propagating tearing shear fracture occurred. Results indicate that the conditions which produce a propagating Mode III tearing shear fracture are not understood. (7 figures) (auth)

868 (KFKI-72-61) QUADRUPOLAR NMR LINE-BROADENING IN Al–3d-TRANSITION METAL ALLOYS. Serfozo, E.; Kovacs-Csetenyi, E.; Gruener, G. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). 1972. 16p. Dep. NTIS (U. S. Sales Only) $4.00.

The second moment of the ^{27}Al NMR signal was measured at room temperature in Al and its alloys with Ti, V, Cr, Mn, Fe, Cu, and Zn. The second moment of pure Al is a sensitive function of metallurgical effects such as cold rolling and quenching, while its concentration dependence as a function of impurity atomic number shows a double-peaked behavior. Comparison of the line broadening with the amplitude reduction of the resonance signal suggests that no drastic preasymptotic effects occur in these alloys. (auth)

869 (RD/B/M-2479(Rev.)) THERMODYNAMIC AND TRANSPORT PROPERTIES OF LIQUID SODIUM. Durham, M. E. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jan 1974. 39p. (CFR/THWP/P-(72)28(Rev.)). Dep. NTIS (US Sales Only) $5.00.

The thermodynamic and transport properties of saturated liquid sodium are presented in graphical and tabular form. Analytic expressions are also given from which the value of the particular property may be found as a function of temperature. SI units are used throughout. The properties of the subcooled liquid can be assumed equal to those of the saturated liquid at the same temperature, with negligible error. Conversion factors are given which enable the data to be expressed in Imperial and cgs units. (auth)

870 (SLA-73-498) PRELIMINARY FRACTURE TOUGHNESS SURVEY OF HIGH STRENGTH STEEL SHEET. Hickerson, J. P. Jr. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 19p. Dep. NTIS $4.00.

A fracture toughness survey was made of 2.04 mm thick sheet from six high-strength steels: 18Ni200, 18Ni250, 18Ni350, HP9-4-20, Almar 362, and PH 1408Mo. Additional tests were also conducted on weldments made on 18Ni200, Almar 362, and HP9-4-20. The test procedures, data analysis, and test results are presented. (5 tables, 4 fig) (auth)

871 (SLL-73-5021) USING CRACK-MOUTH DISPLACEMENT FOR MEASUREMENT AND CONTROL DURING FRACTURE TESTS. Mamaros, T. C.; Jones, A. T. (Sandia Labs., Livermore, Calif. (USA)). Apr 1974. Contract AT(29-1)-789. 20p. Dep. NTIS $4.00.

Techniques are described for monitoring and controlling crack length by means of crack-mouth displacement measurements during fracture toughness tests. Analytical results demonstrate the usefulness of such measurements for a number of specimens. Testing experiences with a variety of brittle alloys, including binary uranium alloys, beryllium, and high-strength aluminums, are discussed; results show that crack-mouth displacement can be used reliably to control fatigue crack growth in very brittle alloys. (auth)

872 (UCLA-34-P-201-9) BRAGG–WILLIAMS AND OTHER MODELS OF THE OMEGA PHASE TRANSFORMATION. de Fontaine, D.; Kikuchi, R. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Dec 1973. Contract AT(04-3)-34. 33p. Dep. NTIS $4.75.

Various previously proposed models of the $\beta \rightarrow \omega$ phase transformation in Ti, Zr, Hf alloys are briefly reviewed. A new Bragg–Williams model of the displacive order–disorder transition is introduced in the single-variant approximation. A closed-form free energy expression is derived which exhibits typical first-order characteristics. A quantitative but approximate prediction is made for the temperature dependence of the long-range order parameter. This parameter measures the degree of advancement of (111)-plane collapse or, equivalently, the amplitude of the 2/3[111] ω-wave. (7 fig) (auth)

873 (USC-113-P-26-X-1) GRAIN BOUNDARY SLIDING DURING HIGH-TEMPERATURE CREEP. Langdon, T. G. (Uni-

versity of Southern California, Los Angeles (USA). Electronic Sciences Lab.). Feb 1974. Contract AT(04-3)-113. 14p. Dep. NTIS $4.00.

Preliminary results for the activation energy for grain-boundary sliding in Mg–0.8% Al indicate that it is very close to that for the total creep process. Theoretical research is also reported on creep and stacking fault energies. (DLC)

874 HYSTERESIS OF THE INTERNAL FRICTION AMPLITUDE DEPENDENCE IN MOLYBDENUM SINGLE CRYSTALS. Golub, T. V.; Benieva, T. Ya.; Polotskii, I. G. (Inst. of Metal Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 67-71(Jan 1974). (In Russian).

Hysteresis of the internal friction amplitude dependence in annealed Mo single crystals was studied as affected by the content of interstitial impurities. The return intervals were determined for amplitude-independent internal friction increased in the process of measurement at high amplitudes. The internal friction return is subjected to the law $t^{\frac{1}{2}}$ (t is a decay time). A decrease in decay is explained by normal diffusion of the interstitial atoms to dislocations. (auth)

875 EFFECT OF DISLOCATIONS AND PURITY OF THE MATERIAL ON THE LOW-TEMPERATURE DAMPING IN Mo MONOCRYSTALS. Myul'bakh, G.; Kaun, L. pp 87-92 of Analiticheskie vozmozhnosti metoda vnutrennego treniya. Tavadze, F. N. (ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

From analytical possibility of the internal friction method symposium; Tbilisi, USSR (Oct 1971). See CONF-711083-.

The internal friction of Mo monocrystals with ⟨110⟩, ⟨111⟩, and ⟨141⟩ orientations, obtained by zone melting after three passes, is studied. Longitudinal oscillations are excited electrostatically with frequencies of about 30 KHz. The study was made on two types of monocrystals which differed from each other by the original material for the zone melting. In the S–Mo samples W is present in quantities of 0.01 to 0.1% and in the T–Mo samples it is present in quantities of about 10^{-4}%. The concentration of interstitial impurities (C, N, O) is about 10^{-3}%. In S–Mo samples the damping is low which is probably connected with the immobilization of the dislocations by the impurities. In both cases on the $Q^{-1}(T)$ curve there is a maximum. The dislocation structure of the samples and the yield point were investigated by electron microscopy. The dependence of the value of the damping on the length of the dislocation segments was established. (tr-auth)

876 MICROSTRUCTURAL INFLUENCES OF FATIGUE CRACK GROWTH IN Ti–6Al–4V. Irving, P. E.; Beevers, C. J. (Birmingham Univ., Eng.). Mater. Sci. Eng.; 14: 229-238(1974).

Fatigue crack growth studies on Ti–6Al–4V at growth rates of 10^{-7} to 10^{-4} mm/cycle in air showed that microstructural variations can produce variations in crack growth rate by a factor between 3 and 10 when testing at R(Lmin/Lmax) = 0.35. Testing at lower R ratio tends to augment these differences. Above a critical value of ΔK (10–12 MN $m^{-3/2}$) the effects disappear, crack growth being structure-insensitive in terms of both growth rate and fracture path. The transition from structure sensitive to structure insensitive can be correlated for all microstructures with the attainment of a critical value of the reverse plastic zone size equal to the α grain size of the microstructure in question. A two-stage model for structure-sensitive crack growth is proposed. (11 figures, 3 tables, 30 references) (auth)

877 STRUKTURA I SVOISTVA ZHAROPROCHNYKH METALLICHESKIKH MATERIALOV. (Structure and Properties of High Heat-Strength Metallic Materials). Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). 263p.

Eleven papers are included in the book concerning development of heat resisting alloys, impurity effects, creep properties, composite materials, and effects of surface treatments. A separate abstract was prepared for each paper. (JRD)

For abstracts of individual papers see: 838 and 878–887.

878 PROSPECTS OF DEVELOPING HIGH HEAT-STRENGTH ALLOYS. Gulyaev, A. P.; Maslenkov, S. B. pp 29-41 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

For use in power plant generators a typical steel containing 1.2% Cr–0.5% MoO–0.3% V shows a creep limit of 19 kg/mm² at 500°C, 11.3 at 550°C, 8.5 at 575°C, and 6.0 kg/mm² at 600°C. The heat-strength properties of perlitic steels is a result of strengthening the ferritic matrix with dispersed carbides VC, $Mo_{23}C_6$, and Mo_2C. However because of the slight ability of ferrite to form alloys the temperature of use is limited to 585°C. In order to use other reactions in the dispersion hardening of iron it is necessary to lower the content of carbon to an upper limit of less than 0.005%. An American steel with 0.002% C and 0.02% B has a long-time strength at the level of austenitic steel (10.5 kg/mm² after 1000 h at 650°C). A ferritic steel strengthened by Laves phases shows strength a factor of 2 or 3 higher after 100,000 h than that of an austenitic steel containing 18% Cr–10% Ni. A typical austenitic steel containing 19% Cr–13% Ni–0.7% Ti shows long-time strength of 11.0 kg/mm² at 600°C, 7.0 at 650°C and 4.5 kg/mm² at 700°C after 10,000 h. Incoloy-type steel containing 26% Cr and 35% Ni showed a strength of 2.9 kg/mm² at 1200°C after 10,000 h. These steels are designated for operation at 1000 to 1300°C. High plasticity is required in service so that alloying cannot be carried above the solubility limit. Data on stability to corrosion by hot gases are usually lacking. An alloy EP-747 containing iron is stable in various gaseous media at 1200 to 1250°C. The heat-strength properties of various alloys of Mo, W, Nb, and Ta at temperatures of 1100 to 3000°C are reviewed. (SJR)

879 DISTRIBUTION OF ELEMENTS IN THE MICRO- AND SUBMICROREGIONS OF HIGH HEAT-STRENGTH STEELS AND ALLOYS. Gruzin, P. L.; Zemskii, S. V.; Rodionov, Yu. L. pp 41-49 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The mechanical and physical properties of high heat-strength steels and alloys of refractory metals are determined to a significant degree by the distribution of alloying elements and impurities, and by the behavior of crystal structure defects in the micro- and submicrovolumes. Autoradiography is used to study the distribution of atoms in the microregion and nuclear resonance in the submicroregions of metals. A microregion is a volume on the order of the size of a grain or subgrain, while a submicroregion is on the order of one or a few coordination spheres. Autoradiography can detect the distribution of elements at a content of 10^{-6}–10^{-6}% in regions of about 10^{-4}cm. A study was made on the microdistribution of carbon in niobium after crystallization, annealing, and cold deformation with subsequent tempering. It is shown that carbon forms segregations at the grain boundaries and in regions having a high density of crystal structure defects. The distribution of carbon was investigated on annealing a composite material consisting of nickel reinforced with tungsten. The carbon concentrated in the peripheral zone around the tungsten wire. Nuclear resonance was used to study the redistribution of alloying elements in iron–chromium alloys. It was found that chromium was redistributed by being concentrated in some regions, and by being depleted in other regions. (SJR)

880 INTERRELATION OF A LOSS IN ALLOY STRENGTH ON HEATING WITH THE REDISTRIBUTION OF ALLOYING ELEMENTS BETWEEN PHASES AND WITH THE EFFECT OF CONTACTING MEDIUM. Apaev, B. A.; Madyanov, S. A.; Mikhailov, S. K. pp 58-63 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

A correlation is noted between the intensity of redistribution of alloying elements and loss of alloy strength. Microinhomogeneities that are formed change continuously with time and temperature, as redistribution of alloying elements takes place. With an increase in homogeneity the loss in alloy strength takes place more slowly and at higher temperatures. The development of inhomogeneities in alloys leads to a decrease in plasticity and to an increase in the critical embrittlement temperature. The corrosion properties of the alloy are adversely affected by formation of inhomogeneities. Carbon plays a dual role. On the one hand it strengthens the base metal by itself. On the other hand it has an indirect effect through the carbon retained in solid solution. Thermodynamic analysis of the interaction of residual gas atmosphere with Mo and Nb alloys and experimental studies showed that oxygen, carbon, and nitrogen had the most harmful effect on the properties of these alloys. New phases (NbN, NbC, Nb_2C, Nb_2O_5, MoO_3, Mo_2C) are formed on the surface of the alloys and along the grain boundaries. Interaction with these impurities leads to a loss in alloy plasticity. Increasing the concentration of oxygen or nitrogen in the working medium to a level of 10^{-1} to 10^{-3}% led to embrittlement of a niobium alloy held in an argon atmosphere for 10 h. Embrittlement takes place as a result of an increase in the concentration of harmful impurity in an inert gas or vacuum over these alloys. To increase the stability of alloy properties it is necessary to minimize the redistribution of alloying elements and to reduce the concentration of active gases in the contacting medium. (SJR)

881 THEORY OF THE HIGH-TEMPERATURE CREEP OF METALS. Ivanova, V. S.; Ermishkin, V. A. pp 64-70 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The main directions in the development of contemporary theory of high-temperature creep are analyzed. On the basis of concepts of dislocation dynamics a formula is derived to estimate the rate of creep which is thus established. Results from experiments on

single crystals of tungsten and molybdenum are presented to show the good agreement with the proposed formula. 24 references. (tr-auth)

882 INCREASE IN THERMAL STABILITY OF COMPOSITE MATERIALS WITH A NICKEL BASE, STRENGTHENED WITH FIBERS OF TUNGSTEN AND MOLYBDENUM BY CONTROLLED ALLOYING OF THE MATRIX. Panin, V. E.; Dudarev, E. F.; Ovcharenko, V. E.; Kochepasov, I. I.; Zayats, I. I. pp 103-111 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The strength properties of composite materials at high temperatures are determined not only by the fiber strength, but also by the mechanism of the interaction at the separation boundary between the reinforcing fiber and the matrix. The main condition for high thermal stability of the composite material is the absence of dissolution of the fiber in the matrix and of matrix elements in the fiber at high temperatures. This dissolution leads to a change in structure and strength properties of the fiber and to the formation of intermetallic compounds at the separation boundaries. A study was made of the effect of alloying nickel with the B-metals (Cu, Al) and 3d-transition metals (Fe, Mn) on the electron structure of nickel and the solubility of W and Mo in nickel. Alloying changes the acceptor ability of the d-band of nickel, and decreases the solubility of W and Mo in nickel as well as the rate of fiber recrystallization. A correlation is established between the change in acceptor ability of the d-band of nickel on alloying, and the solubility of W and Mo in nickel. Methods of complex alloying of nickel are indicated with the purpose of creating thermally stable composites having a nickel base, strengthened by fibers of W and Mo. (SJR)

883 MAIN FACTORS OF ALLOY STRUCTURE DETERMINING ITS HEAT-STRENGTH PROPERTIES. Mirkin, I. L.; Marinenko, L. S.; Lyubchik, M. A. pp 140-146 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The heat-strength of steels is determined by the strength of the interatomic bond of the solid solution, by the fine structure which is characterized by the density and distribution of dislocations, and by disorientation of subgrains. The particle parameters of the second phase, which block dislocation movement, and the thermal stability of the dispersed phase are also very important. A Cr–Mo–V perlitic steel containing 1.3% Cr and 1% Mo was selected for study. Vanadium carbide possessing high dispersability and thermal stability was selected as the strengthening phase. The vanadium content was varied from 0.33 to 0.95%, and the carbon content was increased from 0.08 to 0.26% in order to maintain a V/C ratio of about 4.0. The steel was annealed at 1040°C and additionally heated at 750°C to obtain the structure of ferrite containing carbides. An electron microscopic study showed that the number of carbide particles increased from 9.1×10^{13} to $2.0 \times 10^{15}/cm^3$. Tests on long-term strength at 585°C showed an increase in strength by a factor of 2 (from 7 to 14 kg/mm^2) by increasing the vanadium content from 0.33 to 0.88%. Simultaneously the long-term plasticity after 3000 h falls smoothly from 40 to 5%, that is, by a factor of 8. Nickel and niobium alloys show the same behavior. (SJR)

884 PROSPECTS OF CREATING NEW, HIGH HEAT-STRENGTH NIOBIUM ALLOYS. Zimina, L. N. pp 196-202 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

With complex alloys as examples (Ni–Cr–Fe; Ni–Cr–Fe–Mo–W; Ni–Cr–Mo–W; Ni–Cr–Mo–W–Co–Ti; and Ni–Cr–Co–Mo–W–Al systems) the effect of niobium addition on the mechanical properties and structure of the alloy is pointed out. The mechanical and technical properties of the alloys depend on the presence and ratio of phases present in the alloys (γ'-phase, Ni_3Nb with a rhombic lattice, μ-phase, carbides, and Laves phases). Alloying with niobium must be based on sound data. The cost of alloying with niobium can be reduced by using commercial niobium alloys of Al–Nb (84% Nb), Cr–Nb (62% Nb) and Ni–Nb (33 to 45% Nb). Niobium alloys containing optimum amounts of other alloying ingredients have the following advantages: 1) high weldability with resistance to crack formation, 2) high resistance to gas corrosion from combustion products, 3) combined high heat-strength with long-term plasticity and 4) ready castability in air. (SJR)

885 EFFECT OF NITRIDING ON THE PROPERTIES OF HIGH HEAT-STRENGTH ALLOYS. Lokhtin, Yu. M. pp 225-228 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Nitriding of high heat-strength steels and of titanium is an effective means of increasing the surface hardness, the wear- and seize resistance at room temperatures and at elevated temperatures. Nitriding of molybdenum and niobium along with an increase in hardness and wear stability increases the resistance of the treated materials to high-temperature plastic deformation. With high heat-strength steels, surface nitriding is carried out at 560 to 600°C for 48 to 60 h. The diffusion nitride layer is 0.1 to 0.3 mm in depth with a surface hardness of 800 to 1100 (HV 5). Nitriding time can be shortened a factor of 3 to 4 by carrying out the process at a higher temperature of 680 to 790°C. Titanium is nitrided at 800 to 950°C. Nitriding molybdenum for 3 hours at 1000°C leads to an increase in wear resistance by a factor of 1000. An optimum combination of strength and plasticity at working temperatures of 1000 to 1400°C is attained for niobium by nitriding for one hour at 1200°C, and for molybdenum by nitriding for one hour at 1000°C. Nitriding leads to a significant decrease in plasticity of molybdenum and its alloys at room temperature, while the plasticity of niobium is not affected. (SJR)

886 CREEP AND LONG-TERM STRENGTH OF REFRACTORY MATERIALS WITH PROTECTIVE COVERINGS IN AN OXIDIZING MEDIUM. Kuzub, Yu. I. pp 237-244 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

An estimate is given for the durability of refractory metals and alloys (Mo and Nb alloys) with thermodiffused protective coverings in air at temperatures up to 1100°C. Boride and borosilicide coverings were used. Molybdenum with a boride covering lasted only a few minutes, while with a borosilicate covering it lasted 1.5 to 2.0 h. Oxygen penetrates the pores of the covering and rapidly destroys the molybdenum. Data on the creep rate in air at 1100°C are presented for two covered niobium alloys at various loadings. Creep rates of niobium alloy 1 at 1100°C were in %/min: 0.45 at a loading of 15.05 kg/mm^2, 0.333 at a loading of 13.9, 0.301 at a loading of 9.1, and 0.074%/min at a loading of 6 kg/mm^2. Creep rates of covered niobium alloy 2 at 1100°C in air were in %/min: 4.220 at a loading of 22 kg/mm^2, 1.626 at a loading of 20.7, 0.284 at a loading of 19, 0.031 at a loading of 18, 0.020 at a loading of 17, and 0.008%/min at a loading of 16 kg/mm^2. The behavior of these materials can be predicted. (SJR)

887 NUMBER OF NEW PHYSICAL CRITERIA OF HEAT-STRENGTH. Frantsevich, I. N.; Zhurakhovskii, E. A.; Kalinovitch, D. F.; Kovenskii, I. I. Smolin, M. D.; Ostroukhov, A. N. pp 244-250 of Struktura i Svoistva Zharoprochnykh Metallicheskikh Materialov. Ageev, N. V. (Ed.). Moscow; Izdatel'stvo Nauka (1973). (In Russian).

By studying ion migration in the Ni–Mo system with ^{63}Ni and ^{99}Mo tracers the degrees of ionization of atoms of both components in 5 alloys were obtained as well as values of the free electron density. A correlation of the direction in change of these parameters was established with characteristics of the heat strength. Thermodynamic aspects of the deformed state are illumined. (SJR)

888 MAGNETIC SUSCEPTIBILITY NMR AND THERMOELECTRIC POWER OF DILUTE Ag–Gd ALLOYS. Nakamura, Y. (Tokyo Metropolitan Univ.). J. Phys. Soc. Jap.; 35: No. 3, 729-733(Sep 1973).

Magnetic susceptibility, NMR, and thermoelectric power measurements on dilute Ag–Gd alloys are conducted in temperature regions of 2 to 300°K, 4.2 to 300°K, and 2 to 35°K, respectively. The effective J_{3-f} value is derived from the impurity contribution to the ^{109}Ag NMR line widths as $|J_{3-f}| = 0.28 \pm 0.03$ eV. This value is consistent with that from the specific heat experiment, but considerably larger than that from magnetoresistance. Temperature dependence of the thermoelectric power is nearly independent of concentration and no anomalous peak is observed down to 2°K. (auth)

889 ELECTRON-MICROSCOPE STUDIES OF STRUCTURAL DISLOCATIONS IN MOLYBDENUM MONOCRYSTALS AFTER LOADING WITH CONTACT FRICTION FORCES. Molchanov, B. A.; Kantor, M. M.; Karakozov, E. S.; Voronov, N. I.; Alekhin, V. P. Fiz. Khim. Obrab. Mater.; No. 6, 142-144(1973). (In Russian).

The results of studies are reported on structural dislocations in molybdenum monocrystals after surface loading with contact friction forces through a plastic deformed medium (soft puncture method using Al). The studies were made by a translucent electron-microscope method. The results correlated with earlier data on the principles of contact plastic deformation of material couples of the semiconductor-metal type. (tr-auth)

890 PROPERTIES OF VACUUM CONDENSATES OF Ti, Zr, AND Nb CARBIDES. Ushakova, S. E.; Fat'yanov, V. M. Fiz. Khim. Obrab. Mater.; No. 6, 131-134(1973). (In Russian).

A study was made of the specific electrical resistance, thermal stability, microhardness, strength of bond with the substrate, and the resistance to climate and heat conditions of condensates obtained by electron-beam evaporation in a vacuum of Ti, Zr, and Nb monocarbides. The effect of temperature of the substrate and rate of oxidation on the properties of the films was established. It was found possible to use the carbide condensates as resistance elements. (tr-auth)

891 HIGH-TEMPERATURE LORENZ RATIOS OF Mo AND W. Jones, M.; Hopkins, M. R. (Univ. College of Swansea, Eng.). Phys. Status Solidi (a); 21: No. 2, 507-515(16 Feb 1974).

Measurements of the Lorenz ratio have been made for the two metals molybdenum (900°C to the melting point) and tungsten (900 to 2550°C), these metals being of 99.9% and 99.95% purity, respectively. In both cases the ratio is virtually independent of temperature and lies above the theoretical value of 2.443×10^{-8} V^2 K^{-2}. Estimates of the total thermal conductivities have been made using the resistivity data of independent observers. This parameter has also been separated into its electronic and lattice components by the Wiedemann–Franz–Lorenz and Bäcklund techniques. In both cases lattice thermal resistivity shows an increase with temperature in each material. (auth)

892 Fe_2P-TYPE PHASES IN THE TERNARY ALLOYS OF THE RARE EARTHS WITH Tl AND Pd. Ferro, R.; Marazza, R.; Rambaldi, G. (Univ., Genoa). Z. Metallk.; 65: No. 1, 40-41 (Jan 1974).

The ternary phases of the alloys of the rare earths with thallium and palladium in the stoichiometric ratio 1:1:1 were studied. They resulted in the Fe_2P-type. Results compared with those of the isostructural compounds previously known are briefly discussed. (GE)

893 HIGH PRESSURE GAS SYSTEM WITH APPLICATION TO THE MAGNETIC ORDERING TEMPERATURES OF DYSPROSIUM. Parviainen, S.; Jaakkola, S. (Turku Univ., Finland). Ann. Univ. Turk., Ser. A1; No. 163, 1-11(1973).

A high-pressure system using helium gas and a cryostat with a temperature range of 1.8 to 400°K were constructed to determine the effect of hydrostatic pressures of up to 4 kb on magnetic transition temperatures by the low-field mutual inductance method. The observed pressure shifts for polycrystalline dysprosium were (-0.43 ± 0.02) K/kb and (-1.23 ± 0.02) K/kb for the Néel temperature and for the ferromagnetic–antiferromagnetic transition temperature respectively, in agreement with previous results. (auth)

894 EXAMINATION OF PHASE DIAGRAMS OF THE BINARY SYSTEMS Ce–Co, Pr–Co, AND Nd–Co. Ray, A. E.; Biermann, A. T.; Harmer, R. S.; Davison, J. E. (Dayton Univ., OH). Kobalt; No. 4, 90-93(1973). (In German).

The systems contain intermetallic compounds such as RCo_5, R_2Co_{17}, and R_5Co_{19}, which are important for the achievement of high coercive forces and maximum energy products of cast or sintered permanent magnets on the basis of cobalt and rare earths. The present work is a contribution to the establishment of guidelines for the production and thermal treatment of such alloys, and to provide more detailed knowledge of the magnetic properties of the alloys. Apart from the phase diagrams, the article gives the crystallographic parameters for all intermetallic compounds present in the three systems. (GE)

895 ADHESION OF METALLIC MELTS TO MOLYBDENUM FILMS BY SPRAYING ON THE SURFACE OF OXIDES. Kolesnichenko, G. A.; Kostyuk, B. D.; Naidich, Yu. V.; Shaikevich, S. S. Fiz. Khim. Obrab. Mater.; No. 6, 61-66(1973). (In Russian).

The wettability of thin films of molybdenum sprayed on polished quartz and sapphire surfaces was studied as a function of the thickness of the molten copper. The film structure and nature of the interaction of it with the substrate was studied by an absorption method. With increase in the amount of sprayed metal, the angle of wettability changed from 119 to 16 degrees for Al_2O_3 and from 112 to 16 degrees for SiO_2. The contact angle corresponding to the wettability of compact molybdenum was observed with thick films when the latter was not continuous. This phenomenon is explained with consideration of the developing surface of an islet structure of the film. An increase in temperature resulted in increase in the adhesion of thin films with a substrate by chemical reaction and formation of oxides on the interphase boundary. (tr-auth)

896 PLASTIC DEFORMATION AND DISLOCATION STRUCTURE OF Mo SINGLE CRYSTALS UPON EXTENDING ALONG ⟨110⟩ AND ⟨100⟩ AXES IN RANGE FROM 77 TO 572°K. Kopetskii, C. V.; Pashkovskii, A. I. (Inst. of Solid State Physics, Moscow). Phys. Status Solidi (a); 21: No. 2, 741-751(16 Feb 1974).

An investigation is made of the dislocation structure forming upon straining high-purity single crystals within the range from 77 to 573°K. The single crystals were extended along the ⟨100⟩ and ⟨110⟩ axes. The dislocation structure observation was made using an electron microscope and thin foils cut from deformed specimens. It was established that screw dislocations uniformly distributed in size are predominant in the dislocation structure of deformed crystals at temperatures below 25°C irrespective of the axis orientation of extension. Increasing of the deformation temperature leads to the disappearance of the screw dislocations in the dislocation structure and to formation of a cellular structure. It is shown that at and below room temperature considerably higher growth rate of dislocation density with deformation is observed in crystals extended along the ⟨100⟩ axis. The dislocation density dependence on stress in crystals with ⟨100⟩-orientation in the case of their extension at room temperature has been investigated also. The results obtained are well described by Takeuchi's theory of strain hardening. (auth)

897 QUENCHING EFFECT IN GADOLINIUM: INFLUENCE OF HYDROGEN. Asty, M.; Lemarie, P. H. (CEN, Fontenay-aux-Roses, France). Phys. Status Solidi (a); 21: No. 2, 457-461(16 Feb 1974).

By quenching, even slowly, from above 270°K to liquid nitrogen, the electrical resistance of a cold-worked gadolinium sample has been found to increase; the Arrhenius graph for the quenched-in resistance yields an activation energy of 0.14 eV. On the other hand, a sample well annealed in ultra high vacuum showed no quenching effect. However, for a specimen heated in a hydrogen atmosphere for 5 min at 330°K, and then quenched, an increase of resistance associated with an activation energy of 0.13 eV was observed. This result can be interpreted, for the two cases (cold-worked or annealed and containing hydrogen) in terms of the dissolution and precipitation of hydrogen in the gadolinium lattice. (auth)

898 MICROSTRUCTURES AND SOME PROPERTIES OF Fe–28%Cr–4%Mo ALLOYS. Streicher, M. A. (E. I. du Pont de Nemours and Co., Inc., Wilmington, DE). Corrosion; 30: No. 4, 115-124(Apr 1974).

The effect of heat treatment on the microstructure and properties of 28Cr–4Mo and 28Cr–4Mo–2Ni alloys with low carbon and nitrogen levels was investigated. Sigma and chi phases form in these alloys in the range 1300 to 1700°F. The rate of formation is slow. Heating 1 hour at 1500°F results in only a small amount of sigma phase at grain boundaries. This does not impair corrosion resistance. Annealing at 2000°F readily dissolves this sigma phase, and also much larger amounts of sigma and chi phases formed after heating 100 hours at 1500°F. These alloys are subject to embrittlement by hydrogen. It was shown that embrittlement produced in cold worked material by brief cathodic charging in 10% H_2SO_4 containing a sulfide can be eliminated by exposure to boiling water or aging at room temperature. Both compositions showed excellent resistance to crevice corrosion in a 9 month test in the ocean at the New Jersey shore. Resistance to caustic cracking was demonstrated by a test in 50% NaOH at 392°F. A Type 304, 18Cr-8Ni stainless steel was severely cracked in this test with almost no general corrosion. The 28Cr-4Mo alloy was not cracked but was severely attacked by general corrosion, and the 28Cr-4Mo-2Ni alloy resisted cracking and was also resistant to general corrosion. (auth)

899 RADIAL DISTRIBUTION FUNCTION OF LIQUID SODIUM. Murphy, R. D. (Memorial Univ. of Newfoundland, St. John's); Klein, M. L. Phys. Rev., A; 8: No. 5, 2640-2644 (Nov 1973).

The radial distribution function and static structure factor of liquid sodium at temperatures of 100 and 200°C have been calculated by a Monte Carlo method using a realistic ion-ion potential. The calculated structure factor is in excellent agreement with recent x-ray-diffraction measurements. (auth)

900 HIGH STRENGTH STEELS OF THE FUTURE. Wilson, W. G. (Molybdenum Corp. of America, Pittsburgh). Metals Eng. Quart.; 14: No. 2, 1-7(May 1974).

Lowering the transformation temperature achieves good combinations of strength and toughness in steels. Adding up to 4.5% Mn lowers their transformation temperatures. Using high Mn in combination with low C and Nb (to achieve additional grain refinement) with rolling procedures that maximize production and minimize mill loading presents a combination that will achieve high strength plus fracture toughness. Finally, to obtain high shelf energy, particularly in the direction transverse to rolling, rare earth should be used in sufficient quantities to achieve a minimum Ce/S ratio of 1.5. Such steels can be economically processed in AOD vessels or possibly in Q-BOP units. (12 fig, 3 tables) (auth)

901 NATURE OF THE SULFO-CARBIDES OBSERVED IN NICKEL-BASE SUPERALLOYS. Wallace, W.; Holt, R. T.; Terada, T. (National Research Council of Canada, Ottawa). Metallography; 6: No. 6, 511-526(Dec 1973).

The origin, chemistry, and morphology of sulfur containing phases in powder fabricated and cast nickel-base superalloys are examined, including alloys 713LC, IN-100, and Astroloy. In powder metallurgy (P/M)IN-100 compacts, a titanium sulfocarbide of approximate composition $M_4C_2S_2$ has been identified. In P/M Astrology compacts, a similar phase occurs, while, in P/M 713LC compacts, a zirconium rich phase is observed. Similar particles are observed in the equivalent cast alloys. The particles form as a result of carbon and sulfur segregation either to the interdendritic regions of cast alloys during solidification, or to the liquid grain-boundary pools of P/M compacts exposed to supersolidus grain-growth treatments. The particles are shown to act as crack initiation sites during tensile straining and they are believed to be detrimental to tensile ductility if present in large amounts. (auth)

902 SPIN FLUCTUATION EFFECTS IN RUTHENIUM ALLOYS. Kao, F. C. C.; Williams, G. (Manitoba Univ., Winnipeg). J. Phys., F (London); 4: No. 3, 419-428(Mar 1974).

The electrical resistivity of several dilute RuFe and RuCr alloys was measured between 1.45 and 300°K. The incremental resistivity for the RuCr alloys is temperature independent at low temperatures, although above about 60°K deviations from Matthiessen's rule occur, and these are fitted on the basis of a two current model. For the RuFe system, the incremental resistivity is found to be temperature dependent, increasing as T^2 below about 170°K, but more slowly at higher temperatures. The origin of this temperature dependence is attributed to conduction electron scattering from localized spin fluctuations; confirmatory evidence for this assignment comes from the analysis of existing measurements on the depression of the superconducting transition temperature of Ru by Fe impurities. (auth)

903 GROUP THEORETICAL STUDY OF SELECTION RULES FOR MAGNON–PHONON INTERACTIONS IN FERROMAGNETIC HCP METALS. Cracknell, A. P. (Dundee Univ., Eng.). J. Phys., F (London); 4: No. 3, 466-483(Mar 1974).

The symmetry properties of magnetoelastic waves are exploited to enable selection rules to be determined for the lifting of accidental degeneracy between a phonon and a magnon with the same value of k, the cause of the lifting of the degeneracy being the magnon–phonon interactions. Results are given for ferromagnetic hcp metals and are compared with published dispersion relations from inelastic neutron scattering experiments on Gd, Tb, and Dy. These results are independent of the mechanism postulated for the magnon–phonon interactions. The relation of these general selection rules to selection rules for particular mechanisms is also discussed. (auth)

904 X-RAY PHOTOELECTRON STUDIES OF OXYGEN ADSORPTION ON NIOBIUM METAL. Bahl, M. K. (Univ. of Delhi). J. Phys., F (London); 4: No. 3, 497-502(Mar 1974).

The x-ray photoelectron spectroscopy technique has been applied to study the adsorption of oxygen on the surface of niobium metal foil. It has been found that these measurements provide a method for determining the composition of the surface and for distinguishing between different forms of oxygen present on the surface of the metal. (auth)

905 CONDUCTION ELECTRON DISTRIBUTIONS IN EUROPIUM AND GADOLINIUM BY SOFT X-RAY SPECTROSCOPY. Mariot, J. M.; Karnatak, R. C.; Bonnelle, C. (Univ., Paris). J. Phys. Chem. Solids; 35: No. 5, 657-661(May 1974).

A study of the 5d6s conduction band in Eu and Gd by soft x-ray spectroscopy is presented. The observation that the density of occupied d states is lower for Eu than for Gd is supported by band structure calculations. For Gd, the convolution integrals between the $3p_{\frac{3}{2}}$ inner level Lorentzian distribution and the APW densities of states are compared with experimental M_{III} spectra. The position of the occupied 4f states with respect to the Fermi level is determined, compared with x-ray photoemission data and discussed for both metals. (auth)

906 CRITICAL EXPONENT γ OF EUROPIUM OXIDE. Huang, C. C.; Pindak, R. S.; Ho, J. T. (Univ. of Pennsylvania, Philadelphia). Solid State Commun.; 14: No. 7, 559-562(1 Apr 1974).

The magnetic properties of the localized-spin ferromagnet EuO were measured using Faraday rotation. The exponent γ describing the divergence of the susceptibility above T_c is found to have the value $\gamma = 1.30 \pm 0.02$. The agreement and discrepancy between this result and those of other experiments, model calculations, and speculations on dipolar interactions are discussed. (auth)

907 ADHESION, WETTABILITY, AND FORMATION OF INTERMEDIATE PHASES IN THE SYSTEMS OF TITANIUM-CONTAINING MELT–OXIDE. Naidich, Yu. V.; Zhuravlev, V. S.; Chuprina, V. G. (Inst. of Problems in Materials Science, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 82-85(Mar 1974). (In Russian).

The concentration and temperature dependences are studied for aluminum oxide wettability with a series of Ni–Ti- and Ni–Mo–Ti-melts. It is established that titanium introduced into nickel and nickel-molybdenum melt increases adhesion in the studied systems. The presence of molybdenum also intensifies wetting. The composition of the transition layer in the systems Ni–Ti and Ni–Mo–Ti–Al_2O_3 is investigated at 1500°C. It is shown that in both systems the transition layer consists of titanium oxide Ti_2O_3. The cohesion of the coating with a ceramic body is investigated as influenced by the temperature of oxide-aluminum ceramic metallization. (auth)

908 EFFECT OF COMPRESSIVE PRESTRESSING ON THE MECHANICAL PROPERTIES OF SOME NUCLEAR GRAPHITES. Oku, T.; Eto, M. (Japan Atomic Energy Research Inst., Tokai). Carbon; 11: No. 6, 639-647(Dec 1973).

The effects of prestressing in compression at room temperature on the Young's modulus, tensile strength, and compressive strength of some nuclear graphites were examined. The effects of strain rate in the range of $10^{-5} \sim 10^{-2}$ s^{-1} on the room-temperature tensile and compressive strengths were also investigated. The Young's modulus and the tensile strength of the graphites decreased as the compressive prestress increased above a particular prestress level. However, the compressive strength of the graphites did not change appreciably for the above range of strain rates. The decrease in Young's modulus and tensile strength with increasing prestress is considered to be due to two factors: an increase in the dislocation density, and an increase in the size and number of cracks produced. It is inferred that the decrease in the strength at higher prestress levels is due to the formation and propagation of cracks with increasing prestress, since some growth of cracks was observed in the higher prestressed graphites. (auth)

909 DOPPLER BROADENING OF THE ENERGY DISTRIBUTION OF ANNIHILATION γ-QUANTA IN Zn–Cu ALLOYS. Georgieva, M.; Tumbev, G. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 199-203(1973). (In Bulgarian).

Doppler broadening of the energy distribution of annihilation γ-quanta in Zn–Cu alloys at 0.0, 0.5, 1.0, 1.5, 2.0, 2.75% copper content is investigated by means of Ge–Li detector. It is established that the width of half of the height FWHM changes with the different copper content in the alloy and reaches a minimum in the interval of 0.5 to 1.5%. The supposition is made that in this interval the electric resistance of the alloy should reach maximum value. (auth)

910 Ta THIN FILM RESISTORS REACTIVELY SPUTTERED ONTO SUBSTRATES MOUNTED ON A ROTATING CAROUSEL. Hardy, W. R.; Tam, C. (McMaster Univ., Hamilton, Ont.). J. Mater. Sci.; 9: No. 3, 438-446(Mar 1974).

Ta thin-film resistors were reactively sputtered in 1.5×10^{-5} torr oxygen and 1.5×10^{-5} torr nitrogen simultaneously, using a dc diode system in which the anode is formed by a carousel. The substrates are mounted on this carousel and can be rotated through the discharge. For non-heat-treated films the resistivity increases and the TCR becomes more negative as the carousel rotation speed increases. These changes in electrical properties are attributed to the observed increase in the oxygen concentration and a simultaneous decrease in the nitrogen concentration in the films. The electrical properties are further perturbed by an elongation of the physical structure of the films as a result of carousel rotation. This elongation, which can produce an increased resistivity for a given TCR, is attributed to oblique incidence effects as the substrate rotates into and out of the discharge. Changes produced in the electrical and structural properties of the films during heat treatment at 500°C are shown to depend on carousel rotation speed; recrystallization and surface oxidation occur for films deposited onto a rotating carousel, whereas films deposited onto a stationary carousel undergo surface oxidation only, as indicated by the kinetics of the conductance change and the lack of structural changes as shown by transmission electron microscopy. (auth)

911 VACANCY-SILICON BINDING ENERGY IN ALUMINUM BY POSITRON ANNIHILATION. Kim, S. M.; Buyers, W. J. L.; Martel, P.; Hood, G. M. (Chalk River Nuclear Labs., Ont.). J. Phys., F (London); 4: No. 3, 343-350(Mar 1974).

Measurements were made of the positron annihilation coincidence counting rate at the peak position in Al and in Al–0.27 at. % Si as a function of temperature from 25 to 600°C. Results were analyzed according to the positron trapping model to yield the vacancy formation energy, E_f, and the vacancy–silicon binding free energy. The thermal expansion of the sample and the temperature dependence of the Si solubility were taken into account, and the trapping rate assumed to be temperature independent. For pure aluminum it is found that $E_f = 0.67 \pm 0.03$ eV. For the Al–Si

alloy, a least squares analysis based on the Lomer expression for the vacancy concentration of a dilute alloy shows that the vacancy–silicon binding free energy is 0.12 eV. This is smaller than the binding free energy of 0.20 eV found by Burke and King from length and lattice parameter thermal expansion measurements. If a binding entropy of −2.0k is assumed, as deduced by Balluffi and Ho, then the analysis yields a binding energy of zero to within experimental error. This small value of the binding energy is in good agreement with theoretical calculations based on the Thomas–Fermi method and the self-consistent screening approximation. (auth)

912 MAGNETISM AND RESISTIVITY OF SOME DILUTE RARE EARTH–ZINC COMPOUNDS. Stewart, A. M.; Coles, B. R. (Imperial Coll. of Science and Tech., London). J. Phys., F (London); 4: No. 3, 458-465(Mar 1974).

Measurements were made from 2 to 300°K of the magnetic susceptibilities of polycrystalline specimens of six R_2Zn_{17} and of four RZn_{12} compounds whose resistivities were also obtained, where R is a rare earth. Most of the compounds order antiferromagnetically. The resistivities due to electron–magnon scattering vary with temperature as $T^{1.38}$ for $GdZn_{12}$, $T^{1.45}$ for $TbZn_{12}$, $T^{5.5}$ for $SmZn_{12}$, and $T^{6.5}$ for $ErZn_{12}$. The presence of short-range order was detected far above the Néel points of the two gadolinium compounds. (auth)

913 RESISTIVITY BEHAVIOR AND PHASE TRANSFORMATIONS IN β-W THIN FILM. Petroff, P. M.; Reed, W. A. (Bell Telephone Labs., Inc., Murray Hill, NJ). Thin Solid Films; 21: No. 1, 73-81(Mar 1974).

The resistivity behavior of thin β-W films deposited by rf diode sputtering onto SiO_2 and Si substrates was analyzed in the temperature range 1.4 to 900°K. The film resistivity is found to be controlled by the following factors: (a) the amounts of β-W and α-W in the film, the temperature coefficient of resistivity varying from negative to positive values with decreasing amounts of β-W in the film; (b) the occurrence of an irreversible phase transformation from β-W to α-W at temperatures of 400°K or above; (c) the occurrence of a new phase which forms reversibly below 300°K, tentatively identified on the basis of TEM diffraction data as a tungsten oxide WO_3; (d) the absence of superconductivity down to 1.4°K. This is not well understood and could be attributed to either the appearance of the WO_3 phase or to the presence of impurities introduced during the film deposition. (auth)

914 LATTICE DYNAMICS, THIRD ORDER ELASTIC CONSTANTS AND THERMAL EXPANSION OF GADOLINIUM. Rao, R. R.; Menon, C. S. (India Inst. of Tech., Madras). J. Phys. Chem. Solids; 35: No. 3, 425-432(Mar 1974).

A systematic investigation of the lattice dynamics, second- and third-order elastic constants, and the temperature variation of the effective Grueneisen functions was carried out in gadolinium using Keating's approach. The ten third-order elastic constants are calculated using five anharmonic parameters. The present model reproduces the measured pressure derivatives of the second-order elastic constants of gadolinium well. The low and high temperature limits γ_L and γ_H of the lattice thermal expansion are evaluated. The agreement between the calculated γ_H and that obtained from the thermal expansion and specific heat data of gadolinium is good. (auth)

915 HIGH-TEMPERATURE INTERNAL FRICTION OF SOLID SOLUTIONS HAVING A NICKEL BASE WITH ADDITIONS OF CHROMIUM, TITANIUM, AND MOLYBDENUM. Gridnev, V. N.; Efimov, A. I.; Kushnareva, N. P. Metallofizika; No. 49, 54-63(1973). (In Russian).

Internal friction was investigated up to 1200 to 1300°C over a wide region of concentration values within the limits of a solid solution and at the solubility limit. A determination was made of the concentration region for the existence of two peaks of internal friction, of their temperatures, of the structural dependence in the alloys containing a small amount of alloying element, and of the parameters of the high-temperature maximum in alloys having a high content of alloying element. Annealing twins, the Zeener effect, the K-state do not contribute noticeably to the observed internal friction peaks. The particular parametric changes in low-alloyed mixtures are explained by segregation of alloy elements at grain boundaries. It is proposed that the occurrence of the internal friction peaks is brought about by shear deformation along grain boundaries. (tr-auth)

916 STUDY OF THE EFFECT OF MICROALLOYING WITH RARE EARTHS ON RECRYSTALLIZATION TEXTURE OF NICKEL. Dneprenko, V. N.; Koval, A. D.; Ol'shanetskii, V. E. (Zaporozhe Machine Building Inst., USSR). Metallofizika; No. 49, 69-72(1973). (In Russian).

A study was made of the effect of adding small amounts (1 to 4×10^{-3} at. %) of cerium and lanthanum to carbonyl nickel on the texture of the Ni metal after cold rolling with 95% reduction and after recrystallization. X-rays were used to follow the deformation structure and the recrystallization. It was established that the deformation texture of the metal surface layer characterized by the orientation {001} ⟨110⟩ does not depend on the amount of rare earth metal. At the same time the rare earth has a definite effect on the recrystallization texture described by the orientations {001} ⟨100⟩ and {122} ⟨212⟩. (SJR)

917 PHASE DIAGRAM AND THERMODYNAMIC PROPERTIES OF A NUMBER OF INTERMETALLIC COMPOUNDS IN THE IRIDIUM–CERIUM SYSTEM. Dmitrieva, V. N.; Rezukhina, T. N.; Varekha, L. M.; Vorob'eb, V. D. (Inst. of Metal Physics, Kiev). Metallofizika; No. 49, 109-117(1973). (In Russian).

By the methods of differential thermal analysis, x-ray and metallographic analysis and by determining the microhardness, it was possible to construct a phase diagram for the iridium-cerium system, which include eight intermetallic compounds having the compositions: Ce_4Ir, Ce_3Ir, Ce_2Ir, $CeIr$, $CeIr_2$, $CeIr_3$, Ce_2Ir_7 and $CeIr_5$. Only the Laves phase and $CeIr_5$ melt congruently. The other phases melt with decomposition. Interplanar distances and line intensities are tabulated for $CeIr_3$, Ce_2Ir_7 and $CeIr_5$. The microhardness was 250 kg/mm² for Ce_4Ir, 365 kg/mm for $CeIr_{0.82}$, 855 kg/mm for $CeIr_2$ and 715 kg/mm² for $CeIr_3$. Optical CaF_2 was used as an electrolyte to take emf measurements and to derive thermodynamic data on three intermetallic compounds rich in iridium $CeIr_5$, $CeIr_3$ and the Laves phase $CeIr_2$. (SJR)

918 SAGGING RESISTANCE OF TUNGSTEN WIRE. Kostkowski, A.; Nowak, W. Rudy Metale Niezelaz.; 19: No. 2, 68-70 (Feb 1974). (In Polish).

The sagging of tungsten wire during heating in the range of 900 to 2400°C was investigated. An attempt was made to relate the results to the degree of recrystallization and to the influence of doping additives, based on measurements of internal friction and average microhardness and assessment of recrystallization zones from examination of distribution of measured microhardness values. (auth)

919 FORMATION OF DEFORMATION SUBSTRUCTURES AND ANNEALING IN SINGLE-CRYSTAL MOLYBDENUM ROLLED IN THE (112) PLANE. Dubovitskaya, N. V.; Larikov, L. N.; Sidorenko, S. I. (Inst. of Metal Physics, Kiev). Metallofizika; No. 48, 36-43(1973). (In Russian).

By the methods of optical and diffraction electron microscopy, x-ray analysis, and microhardness measurements, a study was made of the substructures of single-crystal molybdenum after rolling with a different number of passes in the (112) plane along the directions $[\bar{1}\bar{1}0]$, $[\bar{1}\bar{1}1]$ and $[3\bar{1}\bar{1}]$ and after a series of isothermal annealings at temperatures of 1050, 1500 and 2000°C. It is shown that the character of the dislocation deformation structure and the orientation of the crystals depend on the direction of rolling, but to an even greater degree, on the amount of deformation which has a substantial effect also on the mechanism of disorder processes during annealing. (tr-auth)

920 STUDY OF PALLADIUM DIFFUSION IN NICKEL, MOLYBDENUM, AND TUNGSTEN BY THE USE OF ELECTRICAL RESISTANCE. Vorontsova, G. A.; Dekhtyar, I. Ya.; Shalaev, A. M.; Karasev, V. V. (Inst. of Metal Physics, Kiev). Metallofizika; No. 48, 102-107(1973). (In Russian).

By measuring the electrical resistance of foils of nickel, molybdenum, and tungsten covered with a thin layer of palladium it was possible to calculate the diffusion coefficients of palladium in Ni, Mo, and W. Values of the diffusion coefficients (D_0) were found to be 0.35 cm²/sec for Pd–Ni at 20°C, 10^5 cm²/sec for Pd–Mo at −196°C, and 6000 cm²/sec for Pd–W at −196°C. The diffusion coefficient as a function of temperature is given by the following relation: $D = D_0 \exp(-Q/RT)$. Here values of Q are 2.1 eV for Pd–Ni, 3.7 eV for Pd–Mo, and 3.8 eV for Pd–W. This method was used to study the rate and parameters of diffusion in a reactor under conditions of high radiation. It was found that irradiation accelerates the diffusion process at a temperature of about 400°C in Pd–Ni samples, but that processes of thermal diffusion predominate over processes of radiation-stimulated diffusion above 600°C. (SJR)

921 EFFECT OF HIGH-TEMPERATURE ANNEALING ON THE SURFACE STRUCTURE OF SINGLE-CRYSTAL MOLYBDENUM. Kuritnyk, I. P. (Trade Association of Thermal Instrumentation, Lvov). Metallofizika; No. 48, 114-116(1973). (In Russian).

Phenomenological studies are described on the change in surface structure of single-crystal Mo as a result of high-temperature (2000°C) annealing in a vacuum of 10^{-4} mm Hg. It is shown that high-temperature heating has a different effect on various planes of single-crystal molybdenum. The least stable to the effect of

high temperature is the surface coinciding with the crystallographic plane (111). (SJR)

922 INTERDIFFUSION IN THE TITANIUM–ZIRCONIUM SYSTEM. Konstantinov, K. M.; Fedotov, S. G.; Ronami, G. N. pp 213-218 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The distribution of the elements in the Ti–Zr interdiffusion domain is studied by x-ray spectral analysis in the temperature range between 1000 and 1500°C. The interdiffusion coefficients are calculated by Matano's method for concentrations ranging from 5 to 95 at. %. The temperature-dependence parameters of interdiffusion are determined, and a qualitative relationship between the elements, phase diagrams, and concentration dependence of the interdiffusion coefficient is established. (IAA)

923 TERNARY SYSTEMS RARE EARTH METAL–IRON FAMILY METAL–SILICON: COMPONENT INTERACTION AND CRYSTAL STRUCTURES OF COMPOUNDS. Gladyshevskii, E. I.; Bodak, O. I. pp 46-52 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Of the approximately 400 ternary compounds presently known, 165 are found in the rare earth metal–iron family metal–silicon system. In the system Ce–{Fe, Co, Ni}–Si, 4, 7, and 21 compounds are formed respectively. A series of isostructural ternary compounds are found in analogous systems with other rare earth metals. The most representative structural types are $CeGa_2Al_2$ (72 compounds), AlB_2 (23 compounds), $NaZn_{13}$ (18 compounds), $CeNiSi_2$ (16 compounds), $BaCd_{11}$ (15 compounds), and PbFCl (15 compounds). The character of the structure of the phase diagrams of the metallic system and the crystalline structure of the intermetallic compounds are determined by the ratio of the atomic radius of the components and their electron structure. (tr-auth)

924 STRUCTURE AND PROPERTIES OF ALLOYS OF V–Al, Cr–Al, AND V–Cr–Al SYSTEMS IN REGION OF SOLID-SOLUTION BCC ORDERING. Matveeva, N. M. pp 89-94 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

An x-ray study of the crystalline structure of alloys of the V–Al system in the region of the compounds V_2Al and V_3Al on monocrystalline and polycrystalline samples shows that after prolonged annealing at 1200 to 400°C, the alloys do not undergo changes in the A2 structure. The formation in this temperature range of the compound V_3Al with A-15 structure does not occur in contradiction to literature. In Cr–Al in the region of the compound Cr_2Al, in agreement with literature, bcc ordering of the solid solution A2 with strong tetragonal distortion of the lattice is observed at 900°C. Alloying the compound V_2Al with Cr along the cut of the V–Cr–Al system with constant Al content (33.3 at. % Al) leads to stabilization of the bcc solid solution of V, Cr, and Al (α-phase) in a wide range of concentration and temperature. V is dissolved up to 7 at. % in the compound Cr_2Al, replacing Cr atoms (β phase). The phase diagram of the "V_2Al"–Cr_2Al cut represents a diagram with formation of a boundary solution with α and β structure. (tr-auth)

925 DECAY OF THE SOLID BETA SOLUTION IN BETA ALLOYS OF TITANIUM AND ZIRCONIUM DURING TEMPERING. Petrova, L. A.; Grankova, L. P. pp 135-140 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The displacement of the ω phase lines with reference to the position of these lines during constant composition of the ω phase, observed in the early stages of decay of the β solid solution and through the precipitation of the α phase indicates the change of composition in tempering processes and the diffusion mechanism for the formation of the ω phase. By change of the lattice constants of the ω phase of the β solid solution of the Ti alloys with 10.92% Mo and of the IVT alloy (T = 7% Mo, 5.5% Cr, 3% Fe, and 3% Al) during tempering and change of the structure of the Zr alloy with 7.5% Mo and 1% Fe it was assumed, on the basis of metallographic and x-ray analysis, that the ω phase, precipitated from the β solid solution, does not convert directly into the α phase in proportion to the increase of the delay time during tempering but is dissolved in the β solid solution from which the phase is precipitated. (tr-auth)

926 INTERACTION OF INTERSTITIAL IMPURITIES WITH IRON-SUBGROUP METALS IN AS-CAST MOLYBDENUM-BASED DILUTE SOLID SOLUTIONS. Ageev, N. V.; Bokareva, N. N.; Guts, Z. A.; Ignatov, D. V.; Kantor, M. M.; Model, M. S.; Romanchenko, S. G. pp 114-123 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The structure and properties of low-alloy Mo–Fe, Mo–Co, and Mo–Ni castings were examined in order to determine the nature of the positive influence exerted by small additions of iron-subgroup metals (Fe, Ni, Co) on the properties of cast molybdenum containing interstitial impurities in amounts (0.012 wt % C) characteristic of the contemporary level of industrial technology. Comparison of the concentration dependence of some mechanical and physical properties with the changes arising in fine structure during alloying indicates that the rise in placity over a narrow range of additive concentration (0.1 to 0.2 at. %) is not accompanied by any significant change in the average solubility of interstitial impurities. This is explained by redistribution of carbon in local regions near defects of the crystal structure. (41 references) (IAA)

927 STRUCTURAL TRANSFORMATION IN MOLYBDENUM–CARBON ALLOYS DURING QUENCHING AND AGING. Ageev, N. V., Ignatov, D. V.; Kantor, M. M.; Morgunova, N. N. pp 123-128 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Electron diffraction microscopy was used to study the structure of molybdenum alloys containing from 0.010 to 0.025 wt % C after heat treatment involving quenching from a temperature close to the melting point of the Mo + MO_2C eutectic, and after subsequent aging. Quenching at various cooling rates was not successful in preventing decomposition of the solid solution in the Mo–C alloys. In heat treatment for aging, decomposition of solid solution proceeds most vigorously at existing dislocations and Mo–Mo_2C phase boundaries. Studies of mechanical properties in quenched and aged samples are in agreement with electron microscopy data for the structural changes. (IAA)

928 SPECIFIC STRUCTURAL FEATURES OF THE PHASE DIAGRAMS OF THE Ti–Cr–V, Ti–Cr–Nb, AND Ti–Cr–Ta TERNARY SYSTEMS. Budberg, P. B. pp 85-89 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

An analysis is made of the specific structural features of the ternary phase diagrams of the system formed by Ti with metals of the VA group (V, Nb, and Ta) and with Cr. It is shown that with the substitution of V in these systems with its analogs Nb and Ta, the position of the singular cut in the systems and the type of equilibrium of the chemical diagram are changed. The phase diagrams of the Ti–V–Cr system are assigned to the solution type, but the Ti–Nb–Cr and Ti–Ta–Cr diagrams belong to the exchange or displacement type. (tr-auth)

929 PROGRESS IN THE FIELD OF DEFORMABLE MAGNESIUM ALLOYS. Drits, M. E.; Sviderskaya, Z. A. pp 158-166 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

The phase diagrams of the binary systems Mg–Ce, Mg–Nd, Mg–Th, Mg–Y, Mg–Mn, and of the systems Mg–Mn–Nd, Mg–Mn–Th, Mg–Mn–Ni, Mg–Mn–Y, Mg–Nd–Ni, Mg–Nd–Al, Mg–Li–Sn, Mg–Nd–Y, Mg–Nd–Zn, as well as of the systems Mg–Mn–Nd–Ni, Mg–Li–Al–Sn, and Mg–Nd–Zn–Y are studied to gain insight into their strengthening mechanisms and to facilitate selection of the compositions of deformable magnesium alloys and the determination of optimal processing conditions. Several new Mg–Li alloys with specific weights ranging from 1.4 to 1.65 g/cu cm with excellent strength properties both at room temperature and in the 60 to 150°C range are proposed. (5 tables, 36 references) (IAA)

930 ELASTIC PROPERTIES OF ALLOYS OF THE Ti–Al–Mo SYSTEM AS A FUNCTION OF THE COMPOSITION AND HEAT TREATMENT. Fedotov, S. G.; Sinodova, E. P.; Konstantinov, K. M.; Kvasova, N. F. pp 171-176 of Chemistry of Metal Alloys. Moscow; Izdatel'stvo Nauka (1973). (In Russian).

Alloys of the Ti–Al–Mo system containing 1, 3, 5, and 8% Al and up to 20 wt % Mo are studied. It is found that the Mo concentration has no noticeable effect on the elastic properties of the alloys in the equilibrium state. On the other hand, Al tends to appreciably increase the modulus of elasticity of equilibrium alloys and of alloys with a martensitic structure formed by annealing. Al inhibits omega-phase formation in Ti–Mo alloys, and promotes setting of a metastable beta phase that contains less Mo than the alloy and is characterized by low elastic properties. (IAA)

Radiation Effects

Refer also to abstracts 1635, 1940, 1963, 1964, and 2141.

931 (AEC-tr-7538) REVIEW OF BASIC RESULTS OF INVESTIGATION OF THE STATE OF STANDARD FUEL ELEMENTS OF WATER–WATER POWER REACTORS. Votinov, S. N.; Belokolytov, V. S.; Davydov, E. F.; Mayershin, A. A.; Pakhomov, Z. I.; Andreeva, A. B. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). [nd]. Translation of SRARI-P-199. 24p. Dep. NTIS $4.25.

Results of a study of the condition of the fuel elements in the

standard subassemblies of the reactor of the first block of the Novovoronezh Nuclear Power Station are presented, carried out in the course of 2-6 operating periods. The change in the mechanical properties of fuel element cladding made of Zr-1% Nb is shown as a function of the degree of irradiation. It is noted that the mechanical properties at irradiation doses above 3.5×10^{21} n/cm^2 reach saturation. The structure of the cladding is characterized by the presence of hydrides whose concentration increases with an increase in the degree of irradiation. The influence of low-temperature annealing on the mechanical properties and structure of the irradiated Zr-1% Nb alloy was studied. It was found that at annealing temperatures of 350-450°C, practically all of the irradiated samples showed hardening. Increasing the annealing temperature to 550°C causes a return of the characteristics and a reorientation of the hydrides. Data from a radiochemical analysis are presented. The contribution of plutonium to the total combustion reaches 60% at a burning depth of 36.5 kg/tU. An evaluation of the behavior of the failed fuel elements is given. (9 fig) (auth)

932 (CONF-720468-, pp vp Paper 20) NEUTRON IRRADIATION EMBRITTLEMENT OF ASTM A533B STEEL IRRADIATED AT 300 AND 400°C TO FAST NEUTRON FLUENCES OF 1, 5, AND 10×10^{19} n/cm^2. Sievers, G.; Pachur, D. (Kernforschungsanlage, Juelich, Ger.). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

A pressure vessel steel irradiation program is being carried out by Kernforschungsanlage Julich GmbH and jointly sponsored by Verein Deutsche Eisenhuttenleute (VDEh) and the Government of the Federal Republic of Germany. The extent of the program, irradiation equipment, and results are presented. The materials are: MnNiMo V-steel, NiCrMo-steel, and NiCrMo-steel. Also, samples from HSST plates 02 and 03 (ASTM A533-B) are used for reference. The investigation includes specimens from base metal (longitudinal and transverse), weld, and heat-affected zone. The fabrication procedure for the weldment and the mechanical properties are given. Charpy V-notch impact tests, tensile tests at room temperature, and 350°C, Vickers hardness, and metallography are being performed. The irradiation system is described in detail. The temperature of the irradiation rig is controlled by means of a helium-filled thimble. Results obtained from the irradiation of reference material ASTM A533-B (HSST plates) are compared with results available from previous HSST irradiation experiments. (6 figures) (auth)

933 (CONF-720468-, pp vp Paper 21) FRACTURE AND TENSILE PROPERTIES OF IRRADIATED A533 PRESSURE VESSEL PLATE AND SUBMERGED-ARC WELD. Williams, J. A. (Hanford Engineering Development Lab., Richland, WA). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The material is from HSST plate 02 ASTM A533, grade B, class 1 steel. Characterization of embrittlement by irradiation is being evaluated by plane strain fracture toughness, K_{Ic}, measurements using 1-in.-thick compact tension (CT) specimens; tensile behavior was also studied to establish a basic engineering understanding of the irradiation effect on mechanical properties of A533-B. The shift in transition temperature in plane strain fracture toughness, K_{Ic}, due to irradiation was correlated with the effect of irradiation on the yield strength of A533-B pressure vessel steel. The correlation, believed to be valid to fluences of 8×10^{19} n/cm^2 ($E > 0.1$ MeV), is preliminary in nature because of the incomplete determination of the irradiated-material fracture toughness transition. Transverse tensile properties for irradiated and unirradiated ASTM A533-B were compared to longitudinal plate properties. Yield and ultimate strength properties and their response to irradiation were found to be orientation independent. Unirradiated K_{Ic} fracture toughness for WR orientation was also similar to RW orientation fracture toughness. Fracture toughness, K_{Ic}, of ASTM A533-B submerged arc weldment was shifted by about 400°F (from -250 to 150°F) for the 50 ksi $\sqrt{\text{in.}}$ level after irradiation to approximately 3×10^{19} n/cm^2 ($E > 0.1$ MeV). Weld tensile yield and ultimate strength properties were similar to plate properties for equivalent irradiation levels; their sensitivity to irradiation strengthening was greater, since unirradiated weld yield and ultimate strength are lower than for the base plate. (5 figures) (auth)

934 (CONF-720468-, pp vp Paper 22) IRRADIATION OF THICK SECTION COMPACT TENSION SPECIMENS. Mager, T. R. (Westinghouse Nuclear Energy Systems, Pittsburgh). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Fracture toughness data were obtained on A533, grade B, class 1 plate and weldment material in both the unirradiated and irradiated condition ($\sim 5 \times 10^{19}$ n/cm^2). The ASTM recommended criteria for a valid plane strain fracture toughness test result are that both the test specimen thickness "B" and the crack length "a" be $\geq 2.5 (K_Q/\sigma_{ys})^2$, where K_Q is the measured fracture toughness and σ_{ys} is the yield strength. As the test temperature is increased, the yield strength of the material decreases and the fracture toughness increases, requiring an increase in test specimen thickness and crack length in order to meet the ASTM validity criteria. In the unirradiated condition, fracture toughness data showed a sharp upswing in K_{Ic} values near the nil-ductility transition temperature (NDTT). Specimens (up to 12 in. thick) were used to measure the toughness. In the postirradiated condition ($\sim 5 \times 10^{19}$ n/cm^2), (up to 2 in. thick) the displacement of the curve of postirradiation K_{Ic} vs temperature corresponds to approximately the same increment of temperature as the shift in the transition temperature determined from Charpy impact tests. Considering the postirradiated yield strength and the measuring capacity of various size compact tension specimens, the testing of irradiated 4-in.-thick specimens (4 T CT) is required in order to obtain postirradiated K_{Ic} values > 100,000 psi (in.)$^{\frac{1}{2}}$. The paper presents a description of the Battelle Research Reactor, where it is proposed that the specimens be irradiated. The design approach to irradiation of thick section specimens is discussed. Emphasis is placed on the flux attenuation and gamma heating associated with the irradiation of heavy-section specimens (4 T CT). The heavy-section irradiation program is reviewed, from capsule design, dosimetry, etc., through a proposed specimen test schedule. (auth)

935 (CONF-721231-PA, pp 9-25) RADIATION DAMAGE STUDIES USING LOW ENERGY ACCELERATORS. Rao, K. R. (Bhabha Atomic Research Centre, Trombay, India). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

The importance of radiation damage in the fast reactors, fusion reactors, and outer space is pointed out, and the effects of energetic ions (charged particles) on solids are discussed. The use of low-energy accelerators to study radiation damage, to simulate fast neutron damage, and to examine irradiated material (channeling analysis) is described in detail. (DLC)

936 (HEDL-TME-73-47) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, February, March, April 1973. Claudson, T. T. (comp.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1973. Contract AT(45-1)-2170. 212p. AT.

Research from several organizations and laboratories is reported. Emphasis is on stainless steels and pressure-vessel steels; the work includes neutron and ion irradiations, mechanical properties, fracture, cracks, etc. Also reported is research on fatigue of helium-implanted TZM, Ni^+ ion bombardment of Ni, and fracture toughness of SM-1A pressure vessel steel. (DLC)

937 (ORNL-TM-4541) EFFECT OF HIGH HELIUM CONTENT ON STAINLESS STEEL SWELLING. Wiffen, F. W.; Bloom, E. E. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 26p. Dep. NTIS $4.50.

Type 316 stainless steel specimens were irradiated in the HFIR reactor at temperatures between 380 and 680°C to displacement damage levels up to 120 dpa and transmutation-produced helium contents up to 6090 ppM. Swelling in solution-annealed samples was found to be smaller than predicted by the helium swelling models but larger than predicted by fast reactor irradiation results, and the temperature dependence of swelling was also not in agreement with either prediction. Cold work reduced swelling for irradiation temperature up to 600°C but was ineffective at 680°C. For both annealed and cold-worked materials, the swelling was nearly temperature independent between 380 and 600°C but increased markedly at 680°C. Present models are inadequate to explain the swelling results in the presence of these high helium concentrations. (5 tables, 5 figures) (auth)

938 (UCLA-34-P-172-11) PARTICLE SIZE DISTRIBUTION EFFECTS IN PRECIPITATION HARDENING. Fifth Annual Progress Report, 1 January 1973-15 January 1974. Ardell, A. J. (California Univ., Los Angeles (USA). School of Engineering and Applied Science). Feb 1974. Contract AT(04-3)-34. 49p. Dep. NTIS $5.50.

Single-crystal specimens of a Ni-6 wt % Al alloy were mechanically tested in compression at room temperature after aging for various times at 625°C. The critical resolved shear stress (CRSS) was measured and analyzed as a function of average γ' particle size according to the predictions of the theory of precipitation hardening of ordered coherent precipitates presented by Brown and Ham.

Agreement with theory appears to be excellent. The effect of the standard deviation of the particle size distribution on the CRSS appears to be that broadening the distribution tends to lower the CRSS. Single-crystal specimens of a Ni–7.53 wt % Al alloy were doubly aged (first at 800°C for 32 h, then at 600°C for various times) to produce bimodal distributions of γ' precipitates. The aging response of the doubly aged samples is more rapid than when the same alloy is isothermally aged at 600°C. In addition, the samples containing bimodal γ' distributions flow discontinuously at room temperature. The project on specimen preparation for the cross-sectional examination by transmission electron microscopy of irradiated specimens produced thin foils of composite Ni–Al–nichrome which were electron transparent, but not in the important region at the interface. The proton irradiation facility was relocated from UCLA to CSULA, where a new 4 MeV-250 μA Van de Graaff proton accelerator was installed. Preliminary testing indicates that the accelerator will be suitable for our planned irradiation experiments, since small voids and faulted dislocation loops were produced in a Ni–8 at. % Al sample. Results of preliminary experiments on high-voltage electron irradiation of overaged Ni–7 wt % Al and PE-16, using a 1 MeV electron microscope, are described. (DLC)

939 STABLE-DAMAGE COMPARISONS FOR NEUTRON-IRRADIATED SILICON. Srour, J. R. (Northrop Research and Tech. Center, Hawthorne, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 190-195(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Measurements of minority-carrier lifetime degradation have been made for neutron-irradiated silicon which permit the following stable-damage comparisons to be drawn: a) test vehicle (device vs bulk material); b) material type (n-type vs p-type); c) dopant density (data obtained for various resistivities); d) neutron energy (14-MeV vs reactor); e) measurement technique (transient vs steady-state); f) operating condition (data obtained over a wide injection-level range). Primary results are the following: a) the 14-MeV-to-reactor stable damage ratio is insensitive to injection level for a given resistivity; b) measurements of the stable damage ratio were made for bulk silicon and solar cells of various resistivities and nearly all of the values obtained were in the range 2.3 ± 0.4:, c) neutron damage constants for solar cells and bulk material of a particular resistivity are in reasonable agreement if comparison is made at the same injection ratio, provided that the ratio employed is high enough so that such comparisons are not affected by bulk trapping. (auth)

940 RECOMBINATION WITHIN DISORDERED REGIONS: INFLUENCE OF BARRIER HEIGHT ON RECOMBINATION RATE AND INJECTION LEVEL EFFECTS. Curtis, O. L. Jr.; Srour, J. R. (Northrop Research and Tech. Center, Hawthorne, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 196-203(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Disordered regions are highly effective for recombination in neutron-irradiated silicon and germanium. Extension of an earlier analysis is presented which takes into account the effect of recombination on the local carrier concentration, and qualitatively explains various experimental observations, particularly the variation of lifetime with excess density. Comparisons to Gregory's impact model are made, and arguments are presented which favor the present analysis. It is observed that the previous conclusion that impurities are unimportant for recombination in neutron-irradiated material may not be valid for practical situations which involve high excess carrier densities. (6 figs) (auth) (auth)

941 SCANNING ELECTRON MICROSCOPE MEASUREMENTS OF DIFFUSION LENGTH IN NEUTRON-IRRADIATED SILICON. Othmer, S.; Curtis, O. L. Jr. (Northrop Research and Tech. Center, Hawthorne, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 204-208(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Bulk measurements of minority carrier diffusion length in irradiated n-type silicon have been made to determine damage constants for comparison with those derived from photoconductivity decay measurements and to investigate behavior at large neutron fluences. Photoconductivity decay measurements were consistent with those performed previously, while the diffusion length damage constants were consistent with those previously observed on solar cells. Differences in the two sets of values are ascribed to trapping effects and to the higher injection level prevailing in the transient measurements. (auth)

942 ELECTRON PARAMAGNETIC RESONANCE OF THE LATTICE DAMAGE IN BORON-IMPLANTED INTRINSIC SILICON. Beezhold, W.; Brower, K. L. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 209-213(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

The nature of the lattice damage in boron-implanted intrinsic silicon was studied as a function of 140-keV $^{11}B^+$ ion fluence using electron paramagnetic resonance (EPR). At most of the boron fluences, the observed EPR spectra consisted primarily of neutral 4-vacancies (Si-P3) and of unresolved Σ spectra (defects unknown). Concentrations (number/cm^3) for the Si-P3 and Σ paramagnetic defects were determined as a function of ion fluence for fluences ranging from 5×10^{12} to 10^{16} $^{11}B^+$/cm^2. At the highest fluences the beginning of an isotropic resonance indicative of amorphous silicon was also observed. However, only a trace of the amorphous resonance was observed, and this resonance was found to be broadened and shifted to a lower magnetic field with a g value of 2.0071 instead of the usual 2.0055. Also observed at the higher fluences was the new anisotropic spectrum (labeled Si-SL3) arising from a defect having D_{3d} symmetry. Finally, isochronal annealing studies indicate that the Si-P3 and Σ concentrations decrease toward zero by a 225°C anneal in a manner similar to that previously observed for oxygen-implanted silicon. No paramagnetic defects were observed in the 600 to 900°C range. It is concluded that any electrical activity annealing in the 600 to 900°C range is primarily a result of a decrease in the number of compensating nonparamagnetic or diamagnetic defect centers. (5 figures, 23 references) (auth)

943 IRRADIATION-PRODUCED BAND-TAILING IN SEMICONDUCTORS. Kalma, A. H. (Intelcom Rad Tech, San Diego, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 224-228(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Band-tailing produced by electron irradiation at room temperature was studied in various semiconductor materials using infrared absorption. The band-tailing can be produced by both 30- and 1-MeV electrons. GaAs is quite sensitive to the production of band-tailing, and InSb and Si show a lesser effect. PbTe and Ge show no band-tailing produced by these irradiations, but this is more likely due to the annealing of the necessary defects at this relatively high temperature than to any inherent material insensitivity. The annealing of the band-tailing was studied and is found to occur primarily in several well-defined stages. These stages can often be correlated with the annealing stages of isolated defects. Photoconductivity results show that the band-tailing is an absorption phenomenon. This result agrees with previous colorimetric measurements. A hypothesis involving absorption at states produced by disorder in the crystal near the band edge is put forward to explain the various aspects of band-tailing. (10 figures) (auth)

944 INFLUENCE OF γ-IRRADIATION ON SUBSTRUCTURE AND DISTRIBUTION OF COPPER IN Al–Cu SINGLE CRYSTALS. Danil'chenko, B. A.; Krulikovskaya, M. P.; Krulikovskii, B. K.; Chirko, L. I. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 23-27(Jan 1974). (In Russian).

The change in substructure, microhardness (H_μ), and density (ρ) along Al–Cu single crystals (0.14 and 0.18 wt % Cu) grown by the Bridgeman method was studied in a γ-field with power (I_γ) 1 to $3 \cdot 10^3$ R/sec and in the absence of the latter under identical thermal conditions. The values H_μ and ρ were used to determine the copper concentration along the single crystals. Effective segregation coefficients (K_{eff}) were also calculated. It is shown that γ-irradiation results in a more intensive purification of the single crystals than under the usual conditions. This effect increases with I_γ growth. A quantitative dependence of K_{eff} in I_γ is established. A possible mechanism of the observed phenomena is proposed. (auth)

945 DISLOCATION MOTIONS IN STRONGLY ELECTRON-IRRADIATED ALUMINUM. Saka, H.; Noda, K.; Matsumoto, K.; Imura, T. (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 12: No. 10, 1643-1644(Oct 1973).

946 DEFECTS PRODUCED IN METALS BY ION IMPLANTATION USING ELECTRON MICROSCOPY. Ruault, M. O. (Centre National de la Recherche Scientifique, Toulouse); Jouffrey, B.; Chaumont, J. J. Phys. (Paris), Colloq.; No. 5, 21-25(1973). (In French).

From centenary congress of the French Physical Society; Vittel, France (28 May 1973).

Transmission electron microscopy was used to study defects produced by ion irradiation (chiefly in Au targets). The corresponding depth distribution curves are presented and discussed together with some results obtained using electron irradiation in the laboratory's 3-MV high voltage electron microscope. (FR)

947 FORMATION OF VOIDS IN Cu IRRADIATED WITH 500 keV Cu IONS. Glowinski, L. D. (CEN de Saclay, Gif-sur-Yvette, France); Fiche, C.; Lott, M. J. Phys. (Paris), Colloq.; No. 5, 19(1973). (In French).

From centenary congress of the French Physical Society; Vittel, France (28 May 1973).

Studies of the irradiation of thin Cu foils with 500-keV Cu^+ ions established the important role played by gases in the nucleation of voids. (FR)

948 ION IRRADIATION ENHANCED DIFFUSION. Beyeler, M. (CEN de Saclay, Gif-sur-Yvette, France); Fiche, C.; Lott, M. J. Phys. (Paris), Colloq.; No. 5, 125-130(1973). (In French).

From centenary congress of the French Physical Society; Vittel, France (28 May 1973).

The enhanced diffusion of Ni and Cu atoms introduced into Cu and Al monocrystals in the form of Ni^+ and Cu^+ ions (500 keV) was studied. An ion analyzer was used to measure the concentration profiles. The changes in the theoretical and experimental properties of the profiles are compared as a function of temperature. Good agreement was achieved between the theoretically predicted profiles and those observed with samples irradiated at room temperature. Enhanced diffusion was observed for the concentration profiles at high temperatures (10^3 for Ni/Cu at 350°C; 10^2 for Cu/Al at 200°C), the defect production rate being 2×10^{-3} dpa/s. (FR)

949 ELECTRICAL PROPERTIES AND STRUCTURE OF BORON-IMPLANTED GERMANIUM. Gusev, V. M.; Guseva, M. I.; Ionova, E. S.; Mansurova, A. N.; Starinin, C. V. (Inst. of Atomic Energy, Moscow). Phys. Status Solidi (a); 21: No. 2, 413-418 (16 Feb 1974).

Observations are made of crystalline states and measurements of Hall coefficient and conductivity distributions in germanium substrate implanted with 6×10^{13} to 6×10^{17} boron ions per cm^2 at 30 keV before and after annealing at 500°C. In the as-implanted specimen at the dose 6×10^{16} cm^{-2} the concentration of acceptors is more than two orders of magnitude above the maximum solid solubility of boron in germanium. In this case between an amorphous layer and the single crystals, a broad (1200 Å) damaged, but high conductivity region exists, in which the carriers are generated by the implanted boron atoms and radiation acceptors. The anneal treatment influence on the crystal lattice reordering is investigated by the observation of the implanted surface using electron diffraction technique. (auth)

950 CHEMICAL INTERACTIONS OF FISSION PRODUCTS WITH STAINLESS STEEL CLADDINGS. Hofmann, P.; Goetzmann, O. (Kernforschungszentrum, Karlsruhe, Ger.). pp 237-254 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behaviour and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Fission product-enhanced oxidation is the main cause of cladding attack in oxide fuel pins. Cladding attack becomes significant at temperatures above 500°C. To obtain a better understanding of the reaction possibilities of the various fission products, the dependence of those reactions on the clad temperature and the oxygen potential in the system, an out-of-pile test program was undertaken to investigate the compatibility behavior of fission product elements with various types of stainless steels. Results show that reactions between Cs and stainless steel occur only above a certain oxygen potential. The reactions of Te and Se and aggressive fission product elements do not depend on the oxygen potential in the same way as do those of Cs, I and Br in the elementary state cause heavy attack on steel claddings. However, when bonded to Cs they are not dangerous. With surplus oxygen or moisture in the system, though, reactions may occur even with CsI and CsBr. Other fission products like Sb, Cd, In, and Sn also react with steels. The addition of oxygen-consuming materials to the fuel reduces most of the reactions, especially the dangerous ones with Cs. (13 fig) (auth)

951 RADIATION DEFECTS AND LOSS OF STRENGTH IN METALS HAVING A DIFFERENT TYPE OF CRYSTAL LATTICE. Larikov, L. N.; Plotnikova, N. P. (Inst. of Metal Physics, Kiev). Metallofizika; No. 49, 9-28(1973). (In Russian).

Literature data are presented on the radiation defects occurring during neutron irradiation of metals having bcc and fcc lattices. Attention is devoted to problems of the effect of metal purity, dose, and irradiation temperature on the nature, size, and density of defects. Consideration is given to the role of various defects in the loss of strength of irradiated metals. 108 references, 9 tables, 8 figures. (tr-auth)

952 ROLE OF EXCITING THE ELECTRON SUBSYSTEM OF METALS AND ALLOYS IN RADIATION-STIMULATED PROCESSES. Shalaev, A. M. (Inst. of Metal Physics, Kiev). Metallofizika; No. 49, 28-40(1973). (In Russian).

A study of the physical properties of metal systems after irradiation with highly energetic radiation leads to the conclusion that the radiation field stimulates diffusion processes in metals and alloys. The rate of diffusion depends on the concentration of point defects in the material and on the mobility of these defects at a given temperature. The theory of radiation damage of solids is used to predict two basic effects for the interaction of radiation with the crystal lattice: transfer of radiation energy to systems of bound and free electrons, and the formation of point defects. In a field of strong radiation the electron system acquires a certain amount of additional energy. The total free energy of the metal system increases so that it becomes possible that a decrease in activated energy barriers will take place. In this case it is possible to expect a decrease in the activation energy for the movement of crystal lattice defects and of atoms. It is possible to estimate the energy transferred to the crystal lattice as a result of irradiation. An estimate of the energy adsorbed by Be, Al, Ti, Cu, Mo, and Zr is given as a result of irradiation in a fast neutron reactor over a period of 5×10^5 s. The total adsorbed energy is 97.2 eV (30 eV fast neutron and 67 eV from gamma photons) for Be, 288.5 eV for Al (230 eV from gamma photons), 477.6 eV for Ti (425 eV from gamma photons), 854 eV for Cu (615 eV from gamma), 1305 eV for Mo (1160 eV from gamma), and 1241 eV for Zr (1165 eV from gamma photon interaction). An estimate is given for the increase in diffusion as a result of the presence of an excess concentration of point defects. Surface effects on irradiated metals and alloys are discussed. (SJR)

953 IRRADIATION EMBRITTLEMENT AND CREEP IN FUEL CLADDING AND CORE COMPONENTS. Proceedings of the Conference Held in London, England, November 9-10, 1972. London; British Nuclear Energy Society (1973). 305p.

Thirty-three papers were presented in sections entitled: engineering implications, irradiation hardening, irradiation embrittlement, irradiation creep. Information was received on 25 o. the papers and separate abstracts have been prepared for 23 of them. Two were previously abstracted as NSA 27: 10031 and 17900. (UK)

For abstracts of individual papers see: 954-970, 1919, 1961-1964, and 2141.

954 HARDENING OF METALS BY IRRADIATION. Makin, M. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 35-42 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Effects of neutron irradiation on the ductile tensile properties of polycrystalline metals are briefly reviewed. In general these effects include an increase in yield strength, a smaller increase in ultimate strength, and a reduction in uniform elongation to fracture. Although metals of all the three common crystal structures (fcc, bcc, hcp) all show similar general effects, the bcc and hcp metals are sensitive to the presence of interstitial impurities such as C, N, and O. The basic understanding of irradiation hardening depends largely on two types of experiment: (1) single-crystal hardening data, and its correlation with the point defect clusters produced by electron microscopy, and (2) the analysis of the thermal activation characteristics of the deformation. It has been established that in fcc metals irradiation hardening is primarily due to the small vacancy clusters (usually loops) which are nucleated by the cascades produced by energetic primary knock-ons. The deformation characteristics are the result of the destruction of these clusters by glissile dislocations. In the more complex situation in the bcc metals the detailed mechanisms are not so well known. (auth)

955 IRRADIATION RESPONSE OF A GROUP OF COMPLEX ZIRCONIUM ALLOYS. Ells, C. E.; Aitchison, I.; Fidleris, V.; Langford, W. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 43-46 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The effect of neutron irradiation on the tensile strength, tensile ductility, and in-reactor creep strength of four complex zirconium alloys (containing some of the elements Sn, Mo, Nb, Al, and Si) was studied. Compared with the zirconium alloys now in use, i.e., the Zircaloys, Zr-2.5 wt % Nb, and Ozhennite, it is possible to obtain considerably higher tensile strengths from the complex alloys and still maintain satisfactory ductility. At 573°K, the in-reactor creep strength of zirconium alloys seems to be insensitive to alloy composition, but at 723°K the complex alloys have better creep strength than Zircaloy-2 and Zr-2.5 Nb. (auth)

956 INFLUENCE OF FAST NEUTRON IRRADIATION ON DEFORMATION MECHANISMS OF STAINLESS STEEL TYPE AISI

316 L. de Vries, M. I.; Elen, J. D.; Tjoa, G. J.; Mastenbroek, A. (Stichting Reactor Centrum Nederland, Petten). pp 47-56 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Tensile samples of stainless steel type AISI 316L (0.02 % C) were irradiated at 100°C to fast neutron fluences of 1×10^{18} to 3×10^{20} n/cm^2 (E > 0.1 MeV) in the HFR at Petten. The samples were fully annealed (ASTM grain size 7) flat specimens (3 × 1 mm) with 22 mm gage length. The influence of irradiation on macroscopic tensile deformation phenomena are compared with microscopic observations of radiation damage and dislocation structures. The phenomena studied are: temperature and strain rate dependence of the flow stress; yield phenomena and macroscopic work hardening behavior; athermal strain independent radiation hardening. (auth)

957 NEUTRON IRRADIATION EFFECTS ON THE FLOW STRESS COMPONENTS IN X18H9 AND X13 STEELS. Kolesnikov, A. N.; Prochorov, V. I. (Scientific Research Inst. for Atomic Reactors, Dimitrovgrad, USSR). pp 57-60 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The hardening mechanisms operative in X18H9 and X13 stainless steels irradiated to a fast neutron dose of 7.5×10^{20} n/cm^2 (E > 0.8 MeV) at 100°C in the SM-2 thermal reactor were investigated using an incremental stress relaxation method and application of the Cottrell–Stokes law to determine thermal activation parameters. Neutron irradiation did not change the thermally activated deformation mechanism in X18H9 steel which was inferred to be the interaction between mobile and forest dislocations. However, irradiation produced a change in the rate-controlling deformation mechanism in the X13 steel and it was suggested that the hardening in this steel was caused by elastic interaction between mobile dislocations and complex radiation defects. (auth)

958 EFFECT OF FAST NEUTRON IRRADIATION ON THE STRUCTURE AND TENSILE PROPERTIES OF MOLYBDENUM AND TZM. Webster, T. H.; Eyre, B. L.; Terry, E. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 61-80 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Tensile and electron microscopy specimens of zone-refined and commercial purity Mo and commercial purity TZM in various structural conditions were irradiated in DFR at 465, 545, 650, and 680°C to a dose of 1.4 to 1.9×10^{22} n/cm^2 (7 to 9 dpa). Post-irradiation tensile testing at strain rates of $\sim 8 \times 10^{-3}$ and $\sim 4 \times 10^{-4}$ min^{-1}, has revealed that all the materials investigated exhibited zero ductility at room temperature. At test temperatures equivalent to the irradiation temperatures, stress-relieved commercial purity Mo and TZM together with cold-worked four pass zone-refined Mo exhibited ductilities similar to those of unirradiated materials, although these tended to be rather low as is characteristic of cold-worked/stress-relieved materials. Recrystallized Mo and TZM were, however, severely embrittled after irradiation with only the zone-refined material tested at a strain rate of $\sim 4 \times 10^{-4}$ min^{-1} exhibiting any ductility at the two lower irradiation temperatures, 465 and 545°C. All the materials investigated were considerably strengthened by irradiation, the extent of the strengthening generally decreasing with increasing irradiation temperature and initial dislocation density. Transmission electron microscopy has shown that the defect structures produced by irradiation consist of dislocation loops and segments plus a much finer distribution of voids. Whereas the dislocation structures are strongly dependent on irradiation temperature, the void distributions and sizes show a much weaker temperature dependence. The relationship between the defect structures and the changes in mechanical properties are considered and an attempt is made to deduce the relative contributions made by the two defect types to the hardening. (auth)

959 INFLUENCE OF NEUTRON DOSE AND IRRADIATION TEMPERATURE UPON THE ACTIVATION VOLUME OF VANADIUM. Bocek, M. (Kernforschungszentrum, Karlsruhe, Ger.); Elen, J. D. pp 81-91 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The change in ΔV is dependent on the oxygen content as well as on the irradiation temperature. Contrary to unirradiated samples, the activation volume of irradiated vanadium was found to be strain dependent. At the higher irradiation temperature, the formation of large, planar imperfections at the lowest fluences was observed. It is assumed that these imperfections are due to radiation-induced precipitation of interstitial impurities. (auth)

960 HELIUM GENERATION AND DISTRIBUTION IN THERMAL REACTOR IRRADIATED 20% Cr, 25% Ni, Nb STABILIZED STAINLESS STEEL. Manley, A. J.; Rhodes, D. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 103-107 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The helium content of a 20% Cr, 25% Ni, Nb stabilized stainless steel irradiated to a high thermal neutron dose was found to be much higher than could be accounted for by boron-10 (n,α) and fast neutron (n,α) reactions. The additional helium content was consistent with that predicted on the basis of a recently discussed thermal neutron reaction involving nickel. The effect of irradiation temperature and postirradiation annealing on the distribution of voids or gas bubbles in the steel was examined. At low irradiation temperatures, it was shown that a small volume fraction of voids could form. At high irradiation temperatures, the helium contents could be accounted for by the presence of equilibrium filled gas bubbles. (auth)

961 SURVEY OF HELIUM EMBRITTLEMENT OF VARIOUS ALLOY TYPES. Kramer, D.; Garr, K. R.; Pard, A. G.; Rhodes, C. G. (Atomics International, Canoga Park, CA). pp 109-115 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The effect of helium on the uniform and total elongation, at 700°C, of alloys from different classes, was investigated using helium-injected miniature tensile samples. These alloys consisted of simple austenitic stainless steels, austenitic stainless steels with added titanium, nickel-base alloys, ferritic stainless steels plus others. The total elongation of every alloy except TZM was reduced by helium whereas uniform elongations suffered little or no reductions in many cases. The alloys with the best ductility in the presence of helium were 316H (high carbon) and 12R72. (auth)

962 EFFECTS OF IRRADIATION ON THE DIFFERENT STAGES OF CREEP. Shamardin, V. K.; Votinov, S. N.; Prochorov, V. I. (Scientific Research Inst. of Atomic Reactors, Dimitrovgrad, USSR). pp 117-129 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The effects of neutron irradiation on the creep of nickel, austenitic steels, and nickel-base alloys were determined. Irradiation affects the behavior during the heating to the test temperature and at all isothermal creep stages as follows: decreases the instantaneous loading strain; increases or decreases the primary and secondary creep rates; and reduces or completely eliminates the tertiary creep. The magnitudes of these effects are dependent on the material composition, irradiation temperature, and neutron fluence. It is suggested that creep recovery after irradiation below a critical temperature is enhanced due to the annealing of the irradiation induced defects during creep. Annealing of the point defects and/or fine precipitation during irradiation above the critical temperature results in either reductions or no significant effects on the creep rates. (auth)

963 EFFECTS OF NEUTRON IRRADIATION ON THE LOW CYCLE FATIGUE OF 20-25-Nb STEEL. Broomfield, G. H.; Gravenor, J.; Moffat, J.; Hutchins, E. E. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 131-142 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Strip specimens of 20% Cr–25% Ni–Nb stabilized austenitic steel, initially annealed at 960°C, were low-cycle fatigue tested in bending at 700 or 800°C before and after irradiation at 700°C in a thermal materials testing reactor; the test atmosphere was CO_2 with additions of CO and CH_4. Results on the unirradiated steel are related to the bend stress–strain properties by the Tomkins fatigue crack growth model. The endurances are reduced after irradiation, the magnitudes of the reductions decreasing with decreasing cyclic strain amplitude. The irradiation effects on the endurances are correlated with observations on the growth of grain-boundary helium bubbles above a critical stress. (auth)

964 IRRADIATION EMBRITTLEMENT OF AUSTENITIC STAINLESS STEELS. Bagley, K. Q.; Barnaby, J. W.; Fraser, A. S. (United Kingdom Atomic Energy Authority, Dounreay,

Scotland). pp 143-153 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The effects of fast neutron irradiation on the high-temperature mechanical properties of a group of AISI Type 316 stainless steels are surveyed. Materials, in the form of bar tensile test or tube burst specimens, were exposed either in DFR or a Materials Test Reactor (DMTR), achieving fluences between 10^{19} and 10^{23} n/cm^{-2} at reactor ambient temperature and neutron doses up to 3.6×10^{22} n/cm^{-2} at higher temperatures (450 to 650°C). The samples were then tested at temperatures above 500°C under fast straining conditions. The effects of variables, e.g. composition, prior mechanical and heat treatment, irradiation and test temperatures on short-term tensile properties are reported together with microstructural changes observed by optical and electron microscope examination. A simple relationship between loss of ductility (E) and fluence (ϕt) was demonstrated in the temperature range 600 to 700°C, this having the form $\Delta E = K \log (\phi t - c)$. Possible irradiation damage mechanisms are considered but the mechanism based on the growth and coalescence at grain boundaries of helium bubbles generated by (n,α) reactions in the material appears to account most comprehensively for high-temperature embrittlement phenomena. The influence of "voids" formed within the grains, on mechanical strength and ductility is, as yet, uncertain. (auth)

965 INFLUENCE OF HELIUM AND BORON TRACES ON THE MECHANICAL PROPERTIES OF AISI 304L AND 316L AT 600°C. Elen, J. D.; van Witzenburg, W.; de Vries, M. I.; Glas, A. (Stichting Reactor Centrum, Petten, Netherlands). pp 155-166 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

A series of 304L and 316L alloys was prepared with a variation in boron-10 content from 1 to 50 ppM. Tensile specimens in the fully annealed and aged cold-worked conditions were irradiated, in the HFR at Petten, to a fast neutron fluence of about 3×10^{20} n/cm^2 (E > 1 MeV) and thermal fluences of 2.0×10^{20} n/cm^2 and 3.7×10^{20} n/cm^2. The irradiations were performed at 500°C, producing a He content ranging from 0.1 to 15 ppM, mainly through fission of ^{10}B, and at 100°C producing small loop-type damage as well. The influence of He (and of B on the unirradiated controls) on the high-temperature mechanical properties were studied, leading to a comparison of the 100-h creep rupture stress at 600°C. Boron was found to have a positive effect on 304L; the σ_{100h} increased for the fully annealed condition from 16 kg/mm^2 at 3 ppM to 22 kg/mm^2 at 50 ppM. Increasing He impurity reduces the creep rupture strength of the irradiated fully annealed 304L; σ_{100h} drops from 17.8 kg/mm^2 at 0.15 ppM to 15.0 kg/mm^2 at 10.3 ppM. The high-He creep rupture line, however, has a lower slope and the difference in creep strength disappears at about 1000 h. The mechanical properties of the 316L were found to be less sensitive for B or He variation. The influences of irradiation temperature and of the dislocation network in the cold-worked 304L on the mechanical properties at 600°C are discussed in terms of the distribution of helium in the matrix. (auth)

966 POST-IRRADIATION TENSILE PROPERTIES OF ANNEALED AND COLD-WORKED TYPE 316 STAINLESS STEEL. Fahr, D.; Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., TN). pp 167-177 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Tensile properties of annealed and cold-worked type 316 stainless steel irradiated at temperatures between 450 and 850°C to a maximum fluence of 2.7×10^{22} neutrons/cm^2 (E > 0.1 MeV) were compared to those of unirradiated type 316 stainless steel in the as-annealed, annealed and aged (4000 h), as-cold-worked, and cold-worked and aged (4000 h) condition. The results show that fast-neutron irradiation substantially reduces the ductility of the annealed material. The postirradiation work-hardening rate and ductility in the annealed as well as cold-worked material was highest at an irradiation and test temperature of about 500°C. At this temperature, dynamic strain aging took place in both the annealed and cold-worked specimens irradiated at about 500°C while no such contribution to the work-hardening rate could be observed for unirradiated, cold-worked specimens at any temperature. The postirradiation ductility of cold-worked specimens was, therefore, significantly higher than that of unirradiated specimens in the cold-worked and cold-worked and aged condition at temperatures between 450 and 550°C. (auth)

967 HIGH TEMPERATURE EMBRITTLEMENT OF DISPERSION-STRENGTHENED FERRITIC ALLOYS IRRADIATED AT TEMPERATURES UP TO 700°C. van Asbroeck, P.; Vandermeulen, W.; Snykers, M.; Huet, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). pp 179-186 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Dispersion-strengthened ferritic steels were irradiated simultaneously with several austenitic steels in the BR2 reactor up to a fluence of 1.6×10^{22} n/cm^2 at low temperature and to 2×10^{21} n/cm^2 at 700°C. Post-irradiation testing at 700°C showed that: dispersion-strengthened ferritic alloys have higher 700°C total elongation values than austenitic steels and their degree of embrittlement is the smallest; oxide dispersion is beneficial to the resistance to high-temperature embrittlement; and the use of powder metallurgy decreases the irradiation embrittlement. Results are explained by the temperature at which grain boundary cracking first appears. (auth)

968 IRRADIATION CREEP. Hesketh, R. V. (Central Electricity Generating Board, Berkeley, Eng.). pp 221-231 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Irradiation creep is briefly reviewed. There is now a significant number of experiments, ranging from 20 to 750°K, and using fission fragments, deuterons, protons, and neutrons. Materials lying between beryllium and uranium show a creep which is often linear in stress and flux, and remarkably insensitive to temperature and structure. Among the theories, only that of yielding creep has been put to adequate test. In cubic materials, the effect of external stress on the thermal activation of dislocation loop nuclei still appears the best mechanism. The Brownian motion of dislocations and the effect of stress on the displacement energy at dislocations, may also be significant. There appears little reason to link the irradiation creep rate to the irradiation swelling rate. (auth)

969 FURTHER CREEP EXPERIMENTS IN THE DOUNREAY FAST REACTOR. Mosedale, D.; Lewthwaite, G. W.; Ramsay, I. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 233-237 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Findings from further irradiation of helices, loaded in tension and immersed in sodium at temperatures of about 280°C, in the inner breeder of DFR are presented and discussed in the context of previous experiments. Specimen materials comprised eight austenitic stainless steels, Nimonic PE16 alloy, and nickel. Seven of the steels were studied in both cold-worked and solution-treated conditions, one in only the former. The Nimonic alloy was exposed in solution and fully heat-treated conditions and the nickel was annealed. Higher fluence data points largely substantiate trends previously reported, irradiation creep appearing to continue at a steady rate after an initial nonlinear dependence on displacement damage. Further observations of annealed steels irradiated in low-flux positions suggest that these materials initially accelerate in creep rate before slowing down to a steady state. Progress is reported in work aimed at characterizing more fully the materials. It appears that the degree of prior work hardening conditions the amount of primary irradiation creep of the stainless steels, confirming the earlier observations that the cold-worked steels showed, in general, more transient creep than annealed specimens from the same batches. The DFR spring results are discussed relative to other experimental findings and theoretical predictions. (auth)

970 FAST REACTOR INDUCED CREEP IN 20% COLD WORKED TYPE 316 STAINLESS STEEL. Gilbert, E. R.; Kaulitz, D. C.; Holmes, J. J.; Claudson, T. T. (Westinghouse Hanford Co., Richland, WA). pp 239-251 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

A fully instrumented creep test was conducted in EBR-II. Strain in a uniaxial specimen of 20% cold-worked 316 stainless steel stressed at 138 MN/m^2 was measured during irradiation, whereas the diametral strains on four individually pressurized segments of 20% cold-worked 316 stainless steel cladding were determined by post-test measurements. The specimens showed significant flux-induced creep. Both transient and steady-state creep was observed in the uniaxial test. The average strain rates in the pres-

surized tubes indicated linear stress dependence; however, the biaxial transient strains were less on a strain-per-unit stress basis than in the uniaxial specimen. The creep rate during steady-reactor operation was higher than that averaged over several reactor cycles suggesting that strain recovery occurred during reactor outages, even though stress was maintained throughout the outages. The creep rate in 20% cold-worked Type 316 stainless steel was less than that for solution-treated M316 stainless steel springs in DFR and less than that for mill-annealed Type 304L stainless steel in EBR-II when normalized for the specific test conditions. (auth)

Other Materials

Refer also to abstracts 427, 996, 2257, 2263, 2326, 2338–2342, 2344, 2345, 2349, 2351–2358, and 2376.

971 EFFECTS OF ELECTRON RADIATION ON THE ELECTRICAL AND OPTICAL PROPERTIES OF HgCdTe. Mallon, C. E.; Naber, J. A.; Colwell, J. F.; Green, B. A. (Intelcom Rad Tech, San Diego, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 214-219(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

An 80°K 5-MeV electron irradiation of n-type $Hg_{1-x}Cd_xTe$ produced an increase in donor density, Hall mobility, and apparent bandgap. Prior to irradiation, the donor density was 2.6×10^{14} cm^{-3} and increased linearly with electron fluence, with an introduction rate ($dn/d\phi$) of 5.7 cm^{-1}. The 80°K preirradiation Hall mobility of 5.78×10^4 cm^2/V-sec initially increased with irradiation, saturating at a value of about 1.1×10^5 cm^2/V-sec for $\phi = 4 \times 10^{14}$ e/cm^2. The irradiation-induced changes in the Hall mobility and donor density show a nearly complete recovery to their preirradiation values during isochronal anneals to 340°K. An apparent shift in bandgap to higher energy of ~0.035 eV was noted in photoconductivity data following irradiation and partial anneal. This shift in bandgap disappears during anneal, and results in a bandgap value slightly smaller than the preirradiation value after annealing to 340°K. Arguments are given to correlate the apparent bandgap increase and possibly the increased 80°K Hall mobility that is observed after irradiation and prior to anneal, with the onset of degeneracy as the carrier density increases with irradiation. (8 figures) (auth)

972 STUDY OF THERMOSTIMULATED CONDUCTIVITY OF MIXED SINGLE CRYSTALS $CdSe_xTe_{1-x}$. Daniyarov, O.; Lyubchenko, A. V. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 16-22(Jan 1974). (In Russian).

Temperature dependences of photocurrent and curve shapes of thermostimulated current were studied under conditions of temperature dependence of electron lifetime. Parameters of trapping centers (level depths, concentration and trapping coefficient) are determined for a number of samples of $CdSe_xTe_{1-x}$ solid solutions. (auth)

973 ESR INVESTIGATION OF TRITIUM CENTERS IN NEUTRON-IRRADIATED LITHIUM FLUORIDE CRYSTALS. Kamikawa, T. (Yamagata Univ., Japan). Yamagata Daigaku Kiyo, Shizenkagaku; 8: No. 1, 29-35(Jan 1972). (In Japanese).

Lithium fluoride crystals irradiated with neutrons at liquid nitrogen temperature show electron paramagnetic resonance absorption spectra which have doublet structure with a separation of 566 gauss. The observed absorption is ascribed to tritium atoms produced by $^6Li(n,\alpha)^3H$ nuclear reactions. It is concluded from the absorption line shape that the tritium atoms occupy the anion lattice sites in the LiF crystal. On warming the irradiated crystal, the T_1^0 centers begin to increase in concentration at about 100°C, decrease at above 260°C and then disappear at 350°C. Absorption line width reduces in the course of thermal annealing. (auth)

974 THERMAL DIFFUSIVITY OF URANIUM MONOPHOSPHIDE FROM 570 TO 1660 K. Nasu, S.; Takahashi, T.; Kikuchi, T. (Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken, Japan). J. Appl. Phys. 45: No. 1, 494-495 (Jan 1974).

The thermal diffusivity of uranium monophosphide was determined between 570 and 1660 K by a laser pulse method. An anomaly around 970 K found by Menshikova et al. in the heat-capacity-vs-temperature curve was not clearly observed in the thermal-diffusivity-vs-temperature curve. (auth)

975 ELECTRON-IRRADIATION EFFECT IN THE AUGER ANALYSIS OF SiO_2. Thomas, S. (Electron Optics Laboratory, Motorola Semiconductor Products Division, Phoenix, Arizona 85008). J. Appl. Phys. 45: No. 1, 161-166 (Jan 1974).

The principal features in the Auger electron spectrum from a SiO_2 surface are presented. The primary electron beam bombarding the SiO_2 surface has a profound influence on its composition, in that it dissociates the surface leaving it enriched in elemental silicon. The main parameters affecting the dissociation are found to be the electron-beam current density, the beam energy, the presence of impurities on the surface, and the residual gas pressure of oxygen. The effects of these parameters on the dissociation have been studied and some suggestions to minimize the dissociation are made. The results of the present study do not agree with the mechanism proposed by Lineweaver for oxygen release from electron-irradiated glass. (auth)

976 COMPACTION OF ION-IMPLANTED FUSED SILICA. EerNisse, E.P. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 45: No. 1, 167-174 (Jan 1974).

Ion-bombardment-induced compaction of fused silica is measured using a cantilever plate technique for H, He, O, Ne, and A ions with a variety of ion energies. A phenomenological theory is developed which is based on the superposition of two independent compaction mechanisms, one proportional to the density of energy deposited into atomic collisions and the other dependent on the density of energy deposited into electronic excitations. All the present experimental data can be fit to within experimental error with the model using only three adjustable parameters and ion-energy partitioning calculations. Further substantiation of the present energy partitioning calculations and model are provided by showing the proportionality between the density of energy deposited into atomic collisions and other workers' published results for ion-bombardment-induced index-of-refraction changes in quartz and fused silica. It is concluded that the atomic-collision-induced-compaction and index-of-refraction changes are ion independent. Finally, a dose-rate dependence of the ionization-induced compaction is noted for the first time. (auth)

977 EFFECT OF X-RAY IRRADIATION OF CELLS ON NUCLEAR RELAXATION OF OPTICALLY ORIENTED Hg^{199} AND Hg^{201} ATOMS. Kuznetsov, A.N.; Grinko, I.E.; Terzeman, V.F. Opt. Spectrosc. (USSR) 35: No. 3, 238-239 (Sept 1973).

Transverse relaxation times were measured in the 18–300° C temperature range for two odd mercury isotopes before and after x-ray irradiation of cells. The independence of T_2^{201} from the irradiation dose is established. The analogous dependence of T_2^{199} has a saturable character. The behavior of T_2^{199} was investigated in high-temperature annealing of irradiated cells. The results are discussed. (auth)

978 THERMAL CONDUCTIVITY OF BORON AND ITS CRYSTAL-STRUCTURE ANALOG. Golikova, O.A.; Zaitsev, V. K.; Orlov, V. M.; Petrov, A. V.; Stilbans, L. S.; Tkalenko, E. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Status Solidi (a); 21: No. 2, 405-412(16 Feb 1974).

Results are presented of a study of the thermal conductivity of single-crystal β-rhombohedral boron samples, carbon-alloyed boron, α-AlB_{12}, and amorphous boron in the temperature range 80 to 1100°K, and of β-AlB_{12} in the 80 to 400°K range. These data together with published data on the thermal conductivity of $B_{12}As_2$, $B_{12}P_2$, and YB_{66} are considered within the framework of a model taking into account the effect of crystal structure on thermal conductivity. An explanation for the small contribution of optical phonons to the thermal conductivity is suggested. (auth)

979 NEUTRON DIFFRACTION STUDY ON MOLECULAR LIBRATION IN SOLID DCl. Nitmura, N.; Fujii, Y.; Motegi, H.; Hoshino, S. (Tokyo Univ.). J. Phys. Soc. Jap.; 35: No. 3, 842-847(Sep 1973).

Neutron diffraction measurements of DCl using a single crystal revealed that such an anomalous transition as observed in the higher temperature cubic phase of HCl did not occur. Mean square angular displacements due to the molecular libration of DCl were obtained from anisotropic temperatures factors of deuterium atom. Their temperature variation showed a rapid increase in the rate of the 60° molecular flipping with increasing temperature. The difference of the molecular motion between DCl and HCl was observed, which could not be explained by a simple harmonic oscillator model. (auth)

980 GROWTH OF V_k CENTERS BY β RAYS FROM TRITONS. Kazumata, Y. (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 35: No. 4, 1106-1107(Oct 1973).

The growth in concentration of V_k centers by the β-rays from tritium nuclei is observed by ESR. It is clarified that the difference in the growth among the crystals is caused by the different concentration of F-like centers in each crystal. (auth)

981 VISIBLE LUMINESCENCE FROM DIAMOND. Collins, A. T. (King's Coll., London). Ind. Diamond Rev.; 131-137(Apr 1974).

A description is given of the major emission systems in diamond which give rise to luminescence in the visible region, and they are accounted for in terms of the physical and chemical

properties where they are known. Crystal defects due to impurities such as nitrogen and boron, or to radiation damage, are discussed. Photoluminescence and cathodoluminescence are described, and the various special features of the luminescence spectra of diamond are considered in detail. (UK)

982 RADIOINDUCED DEFECTS IN SEMICONDUCTORS. Bourgoin, J. C. (Ecole Normale Superieure, Paris). J. Phys. (Paris), Colloq.; No. 5, 49-60(1973). (In French).

From centenary congress of the French Physical Society; Vittel, France (28 May 1973).

The different stages which govern the production of defects are described. Emphasis is placed on unresolved problems, such as the determination of the threshold energy for displacement, the mobility of the interstitials at low temperature, and the nature of the damage in highly disordered regions. Electronic mechanisms which could induce or enhance the mobility of interstitial or vacancy-type defects are proposed and discussed. (FR)

983 RADIOINDUCED DEFECTS IN MUSCOVITE MICA SAMPLES ASSOCIATED WITH IMPLANTATION. Dartyge, E. (Paris Univ., Orsay, France). J. Phys. (Paris), Colloq.; No. 5, 83-84(1973). (In French).

From centenary congress of the French Physical Society; Vittel, France (28 May 1973).

Small angle x-ray scattering techniques were used to study muscovite mica samples irradiated with high-energy heavy ions (Kr, Ar, Ne, O). Point defects were observed together with defects spreading over larger regions (of the order of 20 Å radius). (FR)

984 EPR MEASUREMENTS IN ION-IMPLANTED DIAMOND. Brosious, P. R. (State Univ. of New York, Albany); Corbett, J. W.; Bourgoin, J. C. Phys. Status Solidi (a); 21: No. 2, 677-683(16 Feb 1974).

A new EPR spectrum, arising from defects in diamond created by boron, carbon, and nitrogen ion-implantation, is observed. The spectrum, lattice damage production, and annealing of damage are discussed and are ascribed to amorphous carbon. (auth)

985 EFFECTS OF STRENGTHENING AND SOFTENING OF ALKALI HALIDE CRYSTALS WITH GAMMA AND X RADIATION. Makara, V. A.; Novikov, N. N. Fiz. Khim. Obrab. Mater.; No. 6, 137-141(1973). (In Russian).

The effect of different doses of gamma (^{60}Co) and x rays on the mechanical properties and dynamic behavior of dislocations in NaCl and KCl crystals was studied. It was shown that, independently of the type of radiation, in the case of large dislocations, the strengthening effect was changed by softening occurring during decreases in radiation dose. The properties and assumptions concerning possible mechanisms of these phenomena are presented. (tr-auth)

986 RADIATION DAMAGE IN II–VI SEMICONDUCTORS. Loferski, J. J. (Brown Univ., Providence). Postepy Fiz.; 25: No. 1, 77-99(1974). (In Polish).

The effects of high energy irradiation on the properties of the II–VI semiconductors, CdS, CdSe, CdTe, ZnS, ZnSe, and ZnTe were investigated. Most of the work has involved electron irradiation experiments aimed at establishing the displacement thresholds for each of the two constituent atoms by observing changes in the luminescence spectra. In all cases, except ZnTe, the energy required to displace the column II atom is higher than the energy required to displace the column VI atom. The observed changes in luminescence consist of the introduction of new luminescence bands, usually in the impurity emission spectral region. (auth)

987 INFLUENCE OF SPECIMEN SIZE AND MODE OF LOADING ON THE FRACTURE OF GRAPHITE. Marshall, P.; Priddle, E. K. (Central Electricity Generating Board, Berkeley, Eng.). Carbon; 11: No. 6, 627-631(Dec 1973).

Predictions of graphite strength under tensile and bending loads using fracture mechanics were compared with experimental data and the Weibull method. The methods are comparable for similar specimens but Weibull's method fails to predict the observed effects for large specimen size differences. Discussion of this failure indicates that the basis of Weibull's theory (a volumetric flaw distribution) may be inapplicable to failure of materials resulting from surface defects. Examination of graphite rods has shown a defect size distribution across the material which leads to prediction of lower strengths for the inner rod regions with respect to the outer regions. Experimental results follow the predicted trend but it is considered that further examination of the fracture mechanics technique must be undertaken before it can be recommended as a design method for graphite materials. (auth)

988 AGEING OF IMPREGNATED CHARCOALS. Taylor, L. R.; Taylor, R. (United Kingdom Atomic Energy Agency, Windscale, Eng.). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Activated charcoals impregnated with potassium iodide or triethylenediamine are widely used for the trapping of iodine species. This report describes laboratory work on accelerated dynamic aging and real-time static aging of impregnated charcoals. From these investigations, an equation which allows predictions of aging performance to be made were developed. Predictions of the aging equation are compared with results from the real-time dynamic aging performance of an installed full-scale iodine trapping plant. (GE)

989 THULIUM AS A MONITOR OF LATTICE DAMAGE IN CADMIUM SULPHIDE. Bryant, F. J.; Goodwin, G. K. (Hull Univ., Eng.). J. Phys., D (London); 7: No. 5, 683-694(21 Mar 1974).

The Tm^{3+} sharp line emission spectrum at 10°K in cadmium sulfide was shown to be very sensitive to electron radiation damage at sample temperatures above 320°K and at incident electron energies above 114 keV (≡8.7 eV sulphur displacement threshold energy). Changes in the rare-earth emission spectra result from the production of complex centers involving thulium ions and sulphur defects. The radiation-induced defects can be removed completely by warming the sample to temperatures greater than 420°K, and activation energies for annealing were determined. (auth)

990 DEFECT FORMATIONS IN THIN CRYSTALS OF LITHIUM FLUORIDE CAUSED BY ELECTRON IRRADIATION. Pashov, N.; Metreveli, P. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 24: 73-79(1973). (In Bulgarian).

In thin LiF crystals obtained by drawing from melts, the defect formations caused by electron irradiation at 100 keV, are investigated using an electron microscope. Several different types of defect formations are found: concentration of point defects, cavitation, dislocation loops. The mean integral density of the defects of the order 5×10^{15} cm^3 is determined. It was established that the carbon layer formed on the crystals under electron microscopy causes the disappearance of part of the defects in the crystal volume. (auth)

991 INFLUENCE OF THE FIELD IONIZATION OF TRAPS AND OF CHARGE EXCHANGE BETWEEN THEM ON THE FLOW OF AN INJECTION CURRENT. Timan, B.L.; Fesenko, V.M. (All-Union Scientific-Research Institute for Single Crystals, Khar'kov). Sov. Phys.-Semicond. 7: No. 3, 319-321 (Sept 1973).

The current–voltage characteristic of the space-charge-limited current is analyzed theoretically making allowance for the field liberation of carriers from traps and for the influence of charge exchange between traps on the permittivity. It is shown that the influence of charge exchange on the permittivity alters the current–voltage characteristic and shifts it toward lower voltages compared with the case of constant permittivity. (auth)

992 CHANGE OF THE INTERPLANAR DISTANCES IN DEEP LAYERS OF SILICON DURING BOMBARDMENT WITH MEDIUM-ENERGY IONS. Uspenskaya, G.I.; Genkin, V.M.; Tetel'baum, D.I. (Physicotechnical Research Institute, N. I. Lobachevskii Gor'kii State University). Sov. Phys.–Crystallogr. 18: No. 2, 224-225 (Sept 1973).

A two-crystal spectrometer is used to find the change in the interplanar spacing $d_{(111)}$ in silicon during bombardment by argon and boron ions at depths up to many times the maximum ion range (up to 50–70 μ). A dependence of $(\Delta d/d)_{(111)}$ on the ion dose is found. It is shown that the deformation has an inelastic character. It has been established that the degree of deformation in the samples with a dislocation density of 10^3 to 10^4 cm^{-2} is greater than in low-dislocation samples. (auth)

993 DYNAMIC MECHANICAL PROPERTIES OF REACTOR GRAPHITES IRRADIATED TO HIGH DOSES. Blankenhorn, P. R.; Kline, D. E. (Pennsylvania State Univ., University Park). Carbon; 11: No. 6, 599-602(Dec 1973).

Properties of polycrystalline graphites irradiated at 338 and 873°K were tested from 100 to 750°K. The dynamic mechanical properties for these specimens indicate multirelaxation behavior. The modulus values increase for all irradiated specimens compared with unirradiated values. For species irradiated at 338°K, radiation damage annealing processes occur when the specimens are tested above 400°K. As expected, data for specimens irradiated at 873°K indicate that some annealing takes place during irradiation. Internal friction data for irradiated specimens exhibit considerable scatter and appear to be complex. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstract 363.

Disposal and Storage

Refer also to abstract 1000.

994 (BNWL-SA-4896) HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL. Liikala, R. C.; McKee, R. W.; Winegardner, W. K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1974. Contract AT(45-1)-1830. 50p. (CONF-740201-3). Dep. NTIS $5.50.

From topical conference on energy; Chicago, Illinois, USA (4 Feb 1974).

The U. S. Atomic Energy Commission (AEC) has and is developing additional plans and new methods for managing radioactive wastes generated by past, present and future operations. The objectives of these programs include plans to: ensure the health and safety of the public; protect our environment and ecology; and use methods acceptable to the public. A brief overview is presented of the plans and current studies for disposing of high-level radioactive waste generated in commercial nuclear facilities. The methodology being developed and used to assess the merits of alternate concepts is presented. The technical areas where the physics community might contribute to improving this program are outlined. (auth)

995 (SLA-74-89) NATURAL CONVECTION IN A SPHERICAL CAVITY WITH UNIFORM INTERNAL HEAT GENERATION. Hardee, H. C. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 40p. Dep. NTIS $5.00.

Radioactive sources placed in cavities in the ground can migrate as a result of melting at the cavity boundary. The direction and character of the migration is determined largely by convective forces in the molten cavity. Two approximate analytical methods, a Rayleigh series expansion for low Rayleigh numbers and a boundary-layer method for high Rayleigh numbers, are used to study natural convection in such a cavity. (auth)

996 PROJECT SALT VAULT: A CASE STUDY IN ROCK MECHANICS. Starfield, A. M. (Univ. of the Witwatersrand, Johannesburg); McClain, W. C. Int. J. Rock Mech. Mining Sci.; 10: No. 6, 641-657(Sep 1973).

The rock mechanics investigations associated with Project Salt Vault, a feasibility study of radioactive waste disposal in an underground salt formation, are outlined. Laboratory and large-scale in situ experiments are briefly described, and a theoretical model is developed which is consistent with laboratory and field observations of creep and thermal effects. The approach outlined can readily be extended from the experimental scale to full-scale design. (auth)

997 PRODUCTION OF RADIOACTIVE WASTES IN ITALY UNTIL THE YEAR 2000. Branca, G.; Gera, F.; Polvani, C. (CNEN, Rome). G. Fis. Sanit. Prot. Radiaz.; 16: No. 4, 168-176(1972). (In Italian).

The main factors on which the production of radioactive wastes depends are considered briefly and include: increase in the total installed electric power and its fraction of nuclear origin; type of newly designed reactors; policy for the reprocessing of irradiated nuclear fuels, etc. The assumptions that can be made on these factors, some derived from official sources, some introduced by the authors themselves, permit an assessment on the amount of radioactive wastes which could be produced in Italy until the year 2000; the values range from a minimum development hypothesis to a maximum development hypothesis. This assessment on future possible wastes has to be considered in connection with the possibility of a rational and timely planning of the technical, administrative and also political interventions necessary to solve in the best way the problems of the treatment and ultimate disposal of radioactive wastes. (auth)

998 RATES OF SALT SOLUTION IN THE PERMIAN BASIN. Swenson, F. A. J. Res. U. S. Geol. Surv.; 2: No. 2, 253-257(1974).

For safe, long-term storage of radioactive materials in salt beds, rates of solution of salt which might imperil such storage must be known. For solution to continue, fluid must move through the system. Major fluid discharge from the system is by surface streams. Using U. S. Geological Survey records of streamflow and chemical quality of water, computations of sodium chloride discharges of numerous subbasins have been made. A map has been constructed showing tons of sodium chloride discharged per day and tons of sodium chloride discharged per square mile per year. Also shown are locations of major saline springs and their rate of discharge of sodium chloride in tons per day. (auth)

Handling Equipment and Procedures

Refer also to abstracts 2000 and 2221.

999 METHOD FOR PROCESSING SCRAP FISSILE MATERIAL INTO A FORM SUITABLE FOR SHIPPING. Weakley, E. A. (to United States Atomic Energy Commission). US Patent 3,779,938. 18 Dec 1973. Filed date 18 Aug 1972. 6p.

Scrap fissile materials and pyrophoric solids are added to a slurry of water and a nonburnable cementing material, masonry cement being preferred, and the resulting agglomeration is poured into a metal can. After the cementing material has been allowed to set to form a solid block within the can, the metal can is sealed with a metal lid. The scraps were thereby encapsulated in the solid cement block preventing exposure to the atmosphere and are held in a fixed lattice in the solid block thereby eliminating any fire hazard and eliminating any potential criticality. The scrap material, held in the billet so produced, is in a form suitable for safely shipping to a fuel scrap recovery plant located at a substantial distance from the place at which the scrap is produced. On arrival at the scrap recovery plant, the metal can is peeled from the solid block. The solid block is inserted whole or broken into smaller chunks and the chunks inserted into a high temperature oven and roasted to decompose the cementing material and convert the fissile material to the oxides. The fissile material is then leached from the oxides in the roasted product with acid which also decomposes any remaining cementing material. The fissile material is subsequently purified by extraction. (Official Gazette)

1000 SOME GUIDELINES ON HANDLING RADIOACTIVE MATERIALS IN HOLLAND AND THE DISPOSAL OF LIQUID RADIOACTIVE WASTES IN RIVERS. Wijker, H. (KEMA, Arnhem, Netherlands). pp A.4.1-A.4.5 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

Numerical methods developed at the KEMA laboratory for estimating the acceptability of procedures for handling radioactive materials and a method for determining the limitations on the amount of liquid radioactive wastes which can be safely discharged in specified rivers are discussed. (LCL)

1001 CRITICALITY DETECTION IN PLUTONIUM LABORATORIES OF C.E.N./S.C.K. Musyck, E. (CEN/SCK, Mol, Belgium). pp B.11.1-B.11.3 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

Equipment and procedures are described, which are used to detect a criticality accident in the plutonium laboratory of the C. E. N. and to produce visible and audible alarms to alert all personnel to evacuate the area. (LCL)

1002 LIFT COUPLING. Preston, M. K. Jr. (to United States Atomic Energy Commission). US Patent 3,795,420. 5 Mar 1974. Filed date 7 Mar 1973. 4p.

A positively locking coupling system especially designed for the positive function necessary in remote handling of highly radioactive loads is described. The coupling is adapted to be remotely operable. (Official Gazette)

Transportation

1003 NATIONAL AND INTERNATIONAL CONTROL AND SAFEGUARDING SYSTEMS FOR THE PEACEFUL USE OF NUCLEAR MATERIALS. Vanni, P. Ing. Nucl.; No. 1, 22-24(1973). (In Italian).

Italian laws and international agreements on the safeguarding of nuclear materials are indicated and their regulations are briefly summarized. (JSR)

1004 REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. 1973 Revised Edition. National

Competent Authorities List No. 6. Safety Series No. 6. Vienna; International Atomic Energy Authority (1974). 18p.

This supplement to the Regulations contains the names of the National Competent Authorities and their addresses supplied by 77 member states. The list will be added to, and kept up to date from time to time. (MCW)

1005 TRANSPORTATION OF STORAGE OF EXPLOSIVES OR OTHER DANGEROUS ARTICLES OR SUBSTANCES AND COMBUSTIBLE LIQUIDS ON BOARD CARGO VESSELS. Fissile Class II (sic) Radioactive Material. Fed. Regist. (Wash., D. C.); 38: No. 30, 4394-4396(14 Feb 1973).

Transport controls for Class III fissile shipments are presented and packaging for fissile radioactive material is described. Requirements and conditions for Atomic Energy Commission approved packages are delineated, along with those for international shipments and foreign-made packages. The shipper is required to insure that proper markings are placed on containers. (Oceanic Abstr.)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 394 and 1554.

1006 (AD-769665) NRL VAN de GRAAFF OPERATION, 1 JANUARY–31 DECEMBER 1972. Dunning, K. L. (Naval Research Lab., Washington, D. C. (USA)). Aug 1973. 71p. (NRL-MR-2653). NTIS $3.50.

The Van de Graaff was modified to accommodate a modified version of the Hill–Nelson sputtering-type ion source in order to provide a beam of nickel ions for the simulation of neutron damage to nuclear reactor materials. This development also opens the way for other experiments with a variety of metallic ions in the MeV energy region. Irradiations of nickel foils, other metals, and alloys were carried out in the simulation program to study void formation in reactor materials. An extensive program on the modification of silicon carbide included ion implantation, luminescence studies, and depth composition profiling of implanted aluminum. A remarkable depth resolution of less than 20 angstroms in the near-surface region was achieved in the profiling work by means of the nuclear resonance method. Exploratory profiling measurements for sodium in thin layers of silicon dioxide were carried out. Many implantations were made in connection with solid-state device development, optical waveguide formation, and to study changes in the optical properties of solids. High resolution measurements of spectra resulting from ion implantation solids have been made to investigate x-ray production and multiple inner-shell vacancy production. (auth)

1007 COLLECTIVE PARTICLE ACCELERATION IN A PLASMA. Rabinovich, M. S.; Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 7-56(1973). (In Russian).

A review of studies on collective methods of particle acceleration in a plasma, which were proposed by Veksler, is presented. Mechanisms are discussed for collective, linear, shock, beam and radiation acceleration. Discussions are presented on the following aspects: basic physical principles, electron rings, creation of bundles by electron beams, relativistic solitons and nonlinear waves as bundles for coherent acceleration, collective linear acceleration, collective pulse acceleration, collective beam acceleration, and collective radiative acceleration. (71 references.) (SJR)

1008 COHERENT SHOCK ACCELERATION. Veksler, V. I.; Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 57-65 (1973). (In Russian).

The study presents the basic ideas of shock acceleration, and calculates the collision dynamics of bundles which are relativistic, charged electron rings. A general theory is given for coherent radiation of bundles in the process of shock acceleration, and estimates are presented on parameters of colliding electron rings, in which coherent radiation is small and the collisions are elastic. (auth)

1009 NEW POSSIBILITIES OF ACCELERATING PARTICLES TO HIGH ENERGIES. Askar'yan, G. A. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 66-72(1973). (In Russian).

This review of studies by the author considers a self-inductive method of accelerating powerful fluxes of charged particles, boundary self-acceleration of a charged bundle in the field of a polarized plasma loop, and acceleration of plasma bundles which scatter powerful electron fluxes (by pressure of an electron flux). (SJR)

1010 ESTIMATING THE MECHANISM OF SHOCK ACCELERATION. Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 73-131(1973). (In Russian).

Mathematical equations are given for calculating the collision of relativistic electron rings so that it becomes possible to describe the dynamics of relativistic collisions and to estimate the coherent radiation flux and charge of a ring in the process of collision. The use of the equations is illustrated in a number of concrete examples. Conditions are determined, where in the process of ring collision it is possible to neglect radiation and slowing down in the interaction, and thus the required conditions are found under which shock acceleration can be realized. (auth)

1011 BIGGEST VAN de GRAAFF MACHINE. Watson, J. (Univ. Coll. of Swansea, Eng.). New Sci.; 61: No. 891, 823-825 (28 Mar 1974).

Forty-three years ago, the inventor of the celebrated high-voltage generator which bears his name, built the world's largest version. The 15 ft diameter spheres could be charged to over 2½ MV. The Van de Graaff generator was conceived as a reliable and fully controllable source of the very high voltages necessary for the acceleration of sub-atomic particles in the early days of atomic disintegration experimentation. With the two spheres permanently joined together for unipolar working it was used to accelerate beams of monoenergetic electrons and ions for the study of electron and x-ray interaction with matter, and for the measurement of nuclear energy levels. By the late 1950s, the big machine had been superseded by its small, completely-enclosed, compressed-gas-insulated descendants. It now delights audiences at the Boston Museum of Science to which it was retired some years ago. (UK)

1012 SYSTEM FOR PRODUCING HIGH ENERGY POSITIVELY CHARGED PARTICLES. Fleischer, A. A.; Hendry, G. O.; Wells, D. K. (to United States Atomic Energy Commission). US Patent 3,794,927. 26 Feb 1974. Filed date 20 Jan 1970. 12p.

A system for producing high-energy positively charged particles which includes in series a source of negative ions; means for axially injecting these ions into a small cyclotron which accelerates the ions to a first energy level; means for extracting negative ions from the cyclotron in a high quality beam; and a two-stage tandem Van de Graaff accelerator which accepts the beam of negative ions at the first energy level, then accelerates them to a second higher energy level, strips their negative charge, and finally accelerates the resulting positive particles to a still higher third energy level is described. (Official Gazette)

1013 APPLIED RESEARCH WORK AT A NEUTRON GENERATOR. Sobczynski, Z. (Inst. for Nuclear Physics, Krakow). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 724-725(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1014 DESIGN, CONSTRUCTION, AND TESTING THE PULSING SYSTEM FOR THE TANDEM GENERATOR OF THE ZENTRALINSTITUT FUER KERNFORSCHUNG, ROSSENDORF. Eckstein, P.; Helfer, H.; Kaetzner, D.; Krause, R.; Lehmann, D.; Linke, W.; Sgonina, A.; Seeliger, D.; Unholzer, S. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 727-728(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

Auxiliaries and Components

Refer also to abstract 357.

1015 STUDY ON SHIELDING FOR BETATRON. 2. Spectra of Primary and Transmitted X Rays Through Various Shielding Materials for 4 to 30 MV X Rays. Maruyama, T.; Sakata, S.; Kumamoto, Y.; Fukuhisa, K.; Hashizume, T. (National Inst. of Radiological Sciences, Chiba, Japan). Shimadzu Hyoron; 30: No. 2-3, 175-180(Sep 1973). (In Japanese).

The photon spectra from a betatron, which is in normal use for radiotherapy, have been measured with a NaI(Tl) scintillation spectrometer. Spectral measurements have been made on primary x rays and secondary radiations transmitted through lead, iron, heavy and ordinary concrete, and a water phantom for 4 to 30 MeV x rays. The measured pulse-height distributions were converted to photon spectra, using an inverse response matrix of the scintillator. The variations in the spectra for different thicknesses of iron slabs were investigated. The resultant spectra are tabulated in the unit of the relative photon number per unit energy interval. The spectra experimentally determined were compared with theoretically calculated thin target spectra. (auth)

1016 STABILIZATION OF THE CASCADE HIGH VOLTAGE. Schmidt, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 693-694(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1017 OPTIMAL DIMENSIONING OF A BEAM CHOPPING SYSTEM ON THE HIGH-ENERGY SIDE OF A TANDEM ACCELERATOR. Helfer, H.; Lehmann, D. (Technische Hochschule,

Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 728-729 (1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1018 CALCULATIONS ON THE BUNCHING OF IONS IN MULTIGAP KLYSTRON SYSTEMS. Seeliger, D.; Sgonina, A. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 729(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1019 OPERATIONAL CHARACTERISTICS OF A TIME-TO-AMPLITUDE CONVERTER FOR USE WITH A CYCLOTRON BEAM. Levon, A. I. (Inst. of Nuclear Research, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 128-129(Jan 1974). (In Russian).

The distortions caused by the hf pickup in the time spectra obtained with a time-to-amplitude converter during measurements on a cyclotron beam were examined. The proposed circuit of the threshold shaper made it possible to eliminate the distorting effects from the periodic pickup. (tr-auth)

Ion Optics and Field Calculations

1020 NONLINEAR THEORY OF RADIATION INSTABILITIES OF RELATIVISTIC RING BEAMS. Bonch-Osmolovskii, A. G.; Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 144-172 (1973). (In Russian).

By applying nonlinear theory it is possible to find the energy level of fields which are excited on development of an instability. It is shown that the radiation instability carries a threshold character, and is stabilized by energy smearing of the beam. A study is made of the problem of stabilizing the instability by external fluctuating fields, and of the dynamics of stabilizing the instability in the absence of sufficiently strong fields at the initial moment of time. Maximum field strength is found for separation of charges arising on development of an instability. (auth)

1021 QUASILINEAR THEORY OF RADIATION FROM A RELATIVISTIC ELECTRON BEAM IN A PLANE, DECELERATING WAVEGUIDE. Akopyan, A. V. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 181-190(1973). (In Russian).

Equations are obtained that describe the quasilinear relaxation of energy intensity and electron distribution function on passage of a relativistic electron beam through an optically decelerating (complex) plane waveguide. An estimate is given for the applicability of quasilinear theory in the case of a beam with a narrow electron momentum dispersion. The relaxation time is found for the energy density which moves to the side of smaller momenta in the form of a shock wave. (auth)

1022 REGULARITY OF THE CHANGE OF MAGNITUDE OF THE ENERGY RESOLUTION OF A CHARGED PARTICLE BEAM WITH QUADRUPOLE LENS. Siksin, V. S. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 88-92(Jan 1974). (In Russian).

The general regularity of the energy resolution was analytically found for systems consisting of sector deflecting magnets and quadrupole lens doublets. This regularity was also applied to systems consisting of a large number of different electron and ion lens. (tr-auth)

Experimental Facilities

Refer also to abstracts 218 and 1783.

1023 (INS-TS-9) SPECIAL MAGNET SETTING TABLE USING TRAPOROULETT MECHANISM AND STEEL BALL RINGS. Fujino, T. (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study). 25 Sep 1973. 12p. (In Japanese). NTIS (US Sales Only).

A 12 ton magnet setting table for the polarization target was designed. A very small rotating radius and the spinning action of the table was obtained with use of "TRAPOROULETT" mechanism. A simple position setting mechanism for the table in the horizontal plane was also designed using steel ball rings. The table is now under construction in the INS machine shop. (auth)

1024 (IPPJ-168) ELECTRON ORBIT IN ERA (ELECTRON RING ACCELERATOR) WITH AN ELECTROSTATIC TYPE INFLECTOR SYSTEM. Toyama, H.; Ishizuka, H. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1973. 9p. NTIS (US Sales Only).

Electron orbits in ERA with an inflector system were calculated. The operational condition for effective capture of the electron beam is represented. (auth)

1025 (JINR-P9-7833) TRENDS OF THE DEVELOPMENT OF HIGH-CURRENT CYCLIC ACCELERATORS: MESON FACTORIES. Dzhelepov, V. P.; Dmitrievskii, V. P.; Lol'ga, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 16p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

The main trends in the development of high-current accelerators, i.e., meson factories, are considered. (auth)

1026 INTERNATIONAL SEMINAR ON PROBLEMS OF NUCLEAR STRUCTURE RESEARCH WITH NEUTRONS, GAUSSIG, GERMANY, NOVEMBER 29-DECEMBER 3, 1971. Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 691-748(1972). (In Several Languages). (CONF-711157-).

Sessions were held on the following subjects: Neutron generators, Measurement and evaluation techniques, Experimental studies of atomic nuclei with neutrons, Preparation of experiments at the tandem generator, and Review talks. Each of the papers was title listed separately. (RWR)

For title listing of individual papers see: 359-361, 418-420, 1013, 1014, 1016-1018, 1027-1030, 1564, 1576, 1577, 1595, 1605, 1606, 1629, 1630, 1673, and 1704-1710.

1027 MODERN NEUTRON GENERATORS. Blumentritt, G. (ZIK, Rossendorf, Ger.). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 691-692(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1028 CHARACTERISTICS AND OPERATIONAL PARAMETERS OF THE NEUTRON GENERATORS OF THE PHYSICS SECTION OF DRESDEN TECHNICAL UNIVERSITY. Schmidt, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 692-693(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1029 PRODUCTION OF TiD AND TiT THICK TARGETS AND INVESTIGATION OF DEPENDENCE OF NEUTRON YIELD FROM REACTIONS D_1d AND T_1d ON IRRADIATION TIME. Pivare, J. (Inst. for Physics, Bratislava). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 694-696(1972).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1030 ABSOLUTE DETERMINATION OF THE DIFFERENTIAL SOURCE STRENGTH OF DD AND DT NEUTRONS. Meister, A.; Seidel, K. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 699-700 (1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1031 STUDY OF THE APPLICATION POSSIBILITIES OF THE LINEAR ELECTRON ACCELERATOR LUE-40 AND MICROTRON LJR FOR THE PURPOSES OF INSTRUMENTAL GAMMA- AND NEUTRON-ACTIVATION ANALYSIS. Duda, J. (Geologicky Pruzkum, Ostrava, Czech.). Radioisotopy; 14: No. 4, 585-622 (1973). (In Czech).

The potentials of two devices of the Joint Institutes of Nuclear Research in Dubna in the field of instrumental activation analysis by means of bremsstrahlung and secondary neutrons are discussed. For generating hard gamma-quanta (E_{ymax} = 35 and 25 MeV) in these devices, intended originally only for basic physical research of the interaction of high energy electrons with matter, the authors constructed and installed an irradiation cell with a convertor system, enabling the use of these devices also for gamma- and neutron activation analysis. Based on a series of measurements of the irradiation, measuring, and evaluation apparatus parameters, an estimation of the analytical values of this setup for the purpose of instrumental gamma- and neutron-activation analysis of some geological and chemical objects was performed. (auth)

1032 CERTIFYING AND UTILIZING MONOENERGETIC NEUTRON SOURCES OF ACCELERATORS. Vasil'ev, R. D.; Kondratenko, S. G.; Shevchenko, V. F.; Yaryna, V. P. Meas. Tech. (USSR) (Engl. Transl.); 16: No. 10, 1523-1526(Oct 1973).

Translated from Izmer. Tekh.; 16: No. 10, 54-56(Oct 1973).

Problems involved in calibration and certification of accelerator monoenergetic neutron sources are discussed. The need for the calibration is outlined, and the method of approach is briefly discussed. (WHK)

1033 NEUTRON SPECTROSCOPY ON THE BASIS OF PROTON BEAMS FROM A MESON FACTORY. Stavisskii, Yu. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 80-81(Jan 1974). (In Russian).

It is shown that, if the storage–buncher on the H^- beam from the meson factory linear accelerator of the Institute of Nuclear Research is used, a neutron spectrometer can be made with a low background level and beam current intensity of the same order as in the better, modern neutron time-of-flight spectrometers (at proton energies of 160 MeV) and two orders of magnitude higher at proton energies of ~600 MeV. (tr-auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 5–8, 423, 1359, and 1419.

1034 (AD-769508) COSMIC RAY TRAJECTORIES IN LOCAL MAGNETIC FIELDS. Gouge, M. J. (United States Naval Academy, Annapolis, Md.). 21 May 1973. 90p. (USNA-TSPR-44). NTIS $3.75.

Several investigators have noticed sidereal and diurnal variations in the cosmic ray flux reaching the Earth. The latter may be explained by periodic changes in the interplanetary magnetic field. The sidereal variations could possibly be produced by discrete galactic sources of cosmic-ray particles. In order to investigate this effect the trajectories of 10 GeV particles arriving at the Earth vertically at Annapolis, Maryland were numerically traced back through the terrestrial and interplanetary magnetic fields. It is found that the trajectory of an experimental maximum flux at 19 hours RA extrapolates backwards to the general direction of the galactic center for a variety of interplanetary sector magnetic field configurations. This indicates that discrete sources, most of which are located at the galactic center, could be responsible for the sidereal variations and the observed maximum flux at 19 hours RA. These results further suggest that the interplanetary magnetic field is not a randomizing field, as several previous investigators have indicated. (auth)

1035 MODEL OF A MOVING MAGNETIC MIRROR AND THE FORBUSH EFFECT IN COSMIC RAYS. Belov, A. V.; Dorman, L. I.; Shakhov, B. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 346-352(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 399-405(1973).

It is postulated that considerable Forbush decreases with a sharp drop are caused by a shock wave which, in a rough approximation, can be treated as a magnetic screen reflecting charged particles. It is shown that a moving screen accelerating and decelerating the particles can be used to explain the intensity increase before a Forbush decrease as well as the Forbush decrease itself for high-energy particles. (auth)

1036 KOSMICHESKIE IUCHI. Fizika Polimerov. (Cosmic Rays. Physics of Polymers). Kocharyan, N. M. Erevan; Izdatel'stvo An Armianskoi SSR (1973). 284p.

The book contains selected works by Kocharian, in the fields of cosmic rays and the physics of polymers. The topics concerning cosmic rays include the absorption of the soft component; the measurement of the soft and hard components; photons in cosmic rays; the mass spectrum of mesons; the ionization losses of high-energy protons; the east-west asymmetry and angular distribution of protons and mesons; nuclear interactions and pions; the design of Geiger–Müller counters, etc. Topics in polymer physics include the piezoeffect in polymethylmetacrylate; the piezoelectric effect in polymers; the dielectric properties of polymers; the absorption of ultrasonic waves in polymers, etc. (IAA)

1037 INSTRUMENT FOR RECORDING THE FLUX AND ENERGY SPECTRUM OF ELECTRONS WITH ENERGIES EXCEEDING 10^8 eV IN COSMIC RAYS. Grigorov, N. L.; Kalinkin, L. F.; Pugacheva, G. I.; Savenko, I. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 494-497 (1973).

Translated from Geomagn. Aeron.; 13: No. 4, 580-584.

The instrument consists of scintillation and Cherenkov counters forming two directional telescopes. The aperture of each telescope is periodically covered by a lead filter 2.7 radiation lengths thick. The possibility of separating electrons from the proton and nuclei background is provided by the difference in the probabilities of formation, in the substance of the filter, of electron—photon showers by electrons and heavier particles. The instrument was calibrated on electron and proton beams from accelerators and also on muons and cosmic-ray electrons at sea level. (auth)

1038 SCIENTIFIC EQUIPMENT FOR STUDYING COSMIC RAYS ON PROGNOZ SATELLITES. I. Volodichev, N. N.; Vorob'ev, A. I.; Grigorov, N. L.; Kolesov, G. Ya.; Kudryavtsev, M. I.; Likin, O. B. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 498-501(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 585-589(1973).

The instruments installed on automatic Prognoz and Prognoz-2 stations for studying charged-particle fluxes and their basic circuits are described. (auth)

1039 PHYSICAL CHARACTERISTICS OF SCIENTIFIC INSTRUMENTS RECORDING THE IONIZING COMPONENT OF COSMIC RAYS ON PROGNOZ SATELLITES. Volodichev, N. N.; Vorob'ev, A. I.; Kolesov, G. Ya.; Kudryavtsev, M. I.; Likin, O. B. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 502-508(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 590-598(1973).

The method used to investigate the characteristics of instruments designed to study the spectra of protons ($E_p > 30$ keV), α-particles, atomic nuclei, and electrons with energies of 3 to 150 keV, and electromagnetic radiation (2.0 to 350 keV) on Prognoz satellites is described. (auth)

1040 PIONEER-10 MEASUREMENTS OF THE DIFFERENTIAL AND INTEGRAL COSMIC-RAY GRADIENT BETWEEN 1 AND 3 ASTRONOMICAL UNITS. Teegarden, B.J.; McDonald, F.B.; Trainor, J.H. (Goddard Space Flight Center, Greenbelt, Maryland); Roelof, E.C.; Webber, W.R. Astrophys. J. Lett. 185: No. 3, L155-L159 (1 Nov 1973).

The Goddard–University of New Hampshire cosmic-ray experiment on Pioneer 10 has provided measurements of the differential radial gradient of cosmic-ray helium nuclei between 1 and 3 a.u. Upper limits are quoted between 10 and 500 MeV per nucleon which are everywhere less than 25 percent per a.u. and in some cases substantially smaller. The integral proton gradient (> 56 MeV) was also measured and found to have the following values: 2.4 ± 0.3 percent per a.u. (1–2 a.u.), 7.6 ± 0.7 percent per a.u. (2–3 a.u.). (auth)

1041 THE INTERPLANETARY QUIET TIME SPECTRA OF PROTONS AND HELIUM BELOW 2 MeV PER NUCLEON BETWEEN 1 AND 3.8 ASTRONOMICAL UNITS. Simpson, J.A.; Tuzzolino, A.J. (Enrico Fermi Institute, University of Chicago). Astrophys. J. Lett. 185: No. 3, L149-L153 (1 Nov 1973).

Proton and helium spectra in the energy range 0.5–1.8 MeV nucleon^{-1} have been obtained simultaneously from the University of Chicago low energy telescopes on the Pioneer-10 spacecraft bound for Jupiter and on the IMP-7 Earth satellite. All spectra may be represented by a power law $E^{-(3.0 \pm 0.3)}$ for both protons and helium nuclei, and yield proton-to-helium abundance ratios at 1 MeV nucleon^{-1} in the range (5.0 ± 0.5). The measured intensity gradients are (8 ± 6) percent per a.u. for protons and (6 ± 5) percent per a.u. for helium nuclei. These results firmly establish that the low-energy turnup spectra observed at 1 a.u. below the well-established modulated galactic spectra, extend undiminished out to at least 3.8 a.u., thus requiring major revisions of theories or models for propagation of low-energy particles of either solar or interstellar origin. (auth)

1042 NEUTRAL-PION-DECAY GAMMA RAYS FROM THE GALAXY AND THE INTERSTELLAR GAS CONTENT. Stecker, F.W. (Theoretical Studies Branch, Laboratory for Space Physics, NASA/Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. 185: No. 2, 499-504 (15 Oct 1973).

Knowledge of the total γ-ray production rate per H atom from the decay of π^0 mesons produced in interstellar cosmic-ray interactions is essential for determining the possible amount of interstellar H_2. This production rate is recalculated here using the latest accelerator data on π^0 production in p-p interactions up to $\sim$1500 GeV. A simple but accurate approximation used here resolves the past disagreement over the magnitude of this rate. An upper limit is obtained of $(1.51 \pm 0.23) \times 10^{-25}$ s^{-1}, consistent with the observed upper limit of 1.6×10^{-25} s^{-1}. (auth)

1043 ROLE OF HYDROMAGNETIC WAVES IN COSMIC-RAY CONFINEMENT IN THE DISK. I. THEORY OF BEHAVIOR IN GENERAL WAVE SPECTRA. Cesarsky, C.J. (California Institute of Technology and Harvard College Observatory, Cambridge, Massachusetts); Kulsrud, R.M. Astrophys. J. 185: No. 1, 153-165 (1 Oct 1973).

The mean free path λ of ultrarelativistic cosmic rays in the presence of a given spectrum of hydromagnetic waves is evaluated. Cosmic rays are scattered in pitch angle by their resonant interactions with hydromagnetic waves; they are also mirror reflected by magnetosonic (or magneto-acoustic) waves. Both effects have to be considered. When the wave spectrum has the Kolmogorov form ($F \propto k^{-5/3}$), λ is a weak function of the rigidity. (auth)

Stars

Refer also to abstracts 1091, 1111, 1112, 1585, and 1818.

1044 (AD-769510) ANALYSIS OF POLARIZATION DATA FOR LATE-TYPE GIANT AND SUPERGIANT STARS. Knotts,

L. H. (United States Naval Academy, Annapolis, Md.). 21 May 1973. 152p. (USNA-TSPR-46). NTIS $4.75.

This investigation constitutes an indepth study of the intrinsic polarization of late type giant and supergiant stars, which will better define the relationships that exist between polarization percentages and other known physical parameters. During the investigation a suitable method of polarimetry was developed and this method was put to use for the detection of stellar polarization. Polarization data was also collected from other reference sources for stars within the spectral region M1 to M6, and this data was examined for suspected relationships with temperature and infrared radiation. The data was also studied with respect to several parameters for which a correlation is not expected, specifically: apparent magnitude, distance, and magnetic field strength. (GRA)

1045 BALMER LINE AND CONTINUUM EMISSION IN EARLY B STARS. Irvine, N. J. Cleveland; Case Western Reserve Univ. (1973). 56p. University Microfilms Order No. 74-2530.

Thesis (Ph. D.).

An examination of the spectra of 75 stars noted as ce in the LS (Luminous Star) catalogues leads to the conclusion that this designation is meaningless for O stars and stars more luminous than class III. The confirmed ce stars are confined almost exclusively to the range B0 - B2 III - Ve. Measures of the strength of the line and continuum emission for the LS stars and a number of brighter Be stars demonstrate that the ce strength is related to the strength of the line emission and to the steepness of the Balmer emission decrement. It does not appear to be related to the projected rotational velocity. Collected observations of the equivalent widths of the hydrogen lines in Be stars show that those stars with the strongest Hα emission tend to have either high or very low projected rotational velocities. For individual stars there is a correlation between the Balmer emission decrement and the strength of the Hα emission. (Diss. Abstr. Int., B)

1046 THE EMISSION-LINE VARIABLE HBV 475. Stienon, F.M.; Chartrand III, M.R. (Warner and Swasey Observatory, Case Western Reserve University, Cleveland, Ohio 44106); Shao, C.Y. Astron. J. 79: No. 1, 47-51 (Jan 1974).

Photometric and spectroscopic studies of the peculiar emission star HBV 475 have been made. A photographic light curve for the past 80 y and objective-prism spectral data before and after the 1966 outburst are presented and discussed. The characteristics of this object resemble those of a symbiotic variable undergoing outbursts. (auth)

1047 PHOTOMETRIC VARIATIONS OF THE HELIUM-WEAK STAR HR1063. Winzer, J.E. (David Dunlap Observatory, University of Toronto, Richmond Hill, Ontario, Canada). Astron. J. 79: No. 1, 45-46 (Jan 1974).

UBV observations of the helium-weak star HR1063=HD21699 are presented. It is found to be variable in light with a period of either 2^d 4761 or 1^d 6780 and amplitudes of 0.03, 0.04, and 0.05 mag in V, B, and U, respectively. The light variations are similar to those observed for the silicon Ap stars. This is the only helium-weak star in which periodic variations have so far been established. (auth)

1048 THE SPECTRA OF SUPERNOVAE. Kirshner, R.P.; Oke, J.B.; Penston, M.V.; Searle, L. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. 185: No. 1, 303-322 (1 Oct 1973).

Absolute spectral-energy distributions have been obtained for a number of supernovae of Types I and II. Included is a comprehensive set of observations, spanning 230 days of the bright Type I supernova 1972e in NGC 5253. Three general conclusions are reached: (1) Both SN I's and SN II's have a continuum which changes slowly and uniformly with time and which carries the bulk of the radiated flux. (2) There exist lines in both SN I's and SN II's which have P Cygni profiles, i.e., broad emissions flanked on their violet edges by broad absorptions. (3) Lines exist which persist through the evolution of the spectrum and which are common to SN I's and SN II's. In SN II's, spectral lines are identified as Hα, Hβ, Hγ, H and K of Ca II, the infrared triplet at λ8600 of Ca II, the sodium D-lines, the magnesium b-lines at λ5180, and possibly also FeII lines. At late stages the [O I] lines λλ6300, 6363, and a line which is tentativley identified as a blend of the [Ca II] lines λλ7291, 7323 is also observed. In SN I's spectral lines are identified as H and K of Ca II, the infrared triplet of Ca II, the sodium D-lines, and the magnesium b-lines. Some two weeks after maximum there is evidence that Hα and Hγ may appear. The Hβ line is in a confused spectra region and its presence cannot be verified. The strong λ4600 feature gradually drifts with time from 4600 Å near maximum light to 4700 Å after 250 days. When it is near 4600 Å it may be a blend of Fe II lines; when it reaches 4700 Å it perhaps should be identified with the He II line at λ 4686. The two SN II's observed have expansion velocities in the outermost regions of 15,000 km s^{-1}, while that of the SN I 1972e in NGC 5253 has 20,000 km s^{-1}. In the case of SN II's, some weeks after maximum light the photospheric temperature is about 5000°K and the electron density in the "reversing layer" is approximately 10^9 electrons cm^{-3}. The dilution factor at this time is approximately 10^{-2}. The number of electrons per cm^2 in the line of sight appears to be approximately 10^{24} which suggests that electron scattering is the main source of opacity. It is suggested that the chemical abundances in SN II's may be approximately solar while hydrogen may be very deficient in SN I's. (auth)

1049 A SEARCH FOR WEAK STELLAR MAGNETIC FIELDS. Borra, E.F.; Landstreet, J.D. (Department of Astronomy, University of Western Ontario, London, Ontario, Canada). Astrophys. J. Lett. 185: No. 3, L139-L143 (1 Nov 1973).

A photoelectric coudé polarimeter has been constructed to measure magnetic fields in bright stars via the circular polarization produced in line wings by the longitudinal Zeeman effect. Twenty-one stars have been observed, with standard errors ranging from 7 to 650 gauss. A field of up to $\sim 10^3$ gauss has been marginally detected in the F8 Ia star γ Cyg on several occasions. A field was found in β CrB, and upper limits were placed on the fields of the remaining 19 stars. (auth)

1050 HIGH-RESOLUTION ZEEMAN POLARIMETRY. Borra, E.F.; Landstreet, J.D. (Department of Astronomy, University of Western Ontario, London, Ontario, Canada); Vaughan, A.H. Jr. Astrophys. J. Lett. 185: No. 3, L145-L147 (1 Nov 1973).

Photoelectric Zeeman observations have been obtained at a resolution of 0.038 Å using a line-profile scanning polarimeter together with a Fabry-Perot interferometer. Fields measurements are reported for the magnetic Ap star β CrB, while negative results are found in α CMa, α^2 Lib, and ι CrB with standard errors ranging from 9 to 185 gauss. (auth)

1051 X-RAY SPECTRUM OF THE TYCHO SUPERNOVA. Coleman, P.L.; Bunner, A.N.; Kraushaar, W.L.; McCammon, D.; Williamson, F.O. (Department of Physics, University of Wisconsin, Madison); Kellogg, E.; Koch, D. Astrophys. J. Lett. 185: No. 3, L121-L125 (1 Nov 1973).

Uhuru satellite data combined with Wisconsin rocket data suggest that the X-ray spectrum of the Tycho supernova remnant is composite and includes a thermal as well as a nonthermal component, the latter being an extension of the radio spectrum. Attempts have been made to fit the low-energy observations (thermal component) with the Tucker and Koren calculations for the solar corona.
corona. (auth)

1052 OBSERVATIONS OF He I $3\,^1P$-$2\,^1S$ λ5016 AND DERIVED OPTICAL DEPTHS IN SIX PLANETARY NEBULAE. Bernat, A.P. (Department of Astronomy, The University of Texas, Austin). Astrophys. J. 185: No. 2, 573-576 (15 Oct 1973).

Spectrophotometric observations of the intensity of He I $3\,^1P$-$2\,^1S$λ5016 relative to [O III] λ5007 for six planetary nebulae are given. Using literature values for I(5007)/I(He I 4^3D-2^3P λ4471), a comparison with published transfer models is made to derive optical depths in the He I singlet bound-free continuum and populations in the $1\,^1S$ ground state. The singlet He^0 abundance does not appear to be high enough to modify previously accepted He/H ratios. (auth)

1053 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. VIII. THE BLUE Ap STARS. Leckrone, D.S. (National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland). Astrophys. J. 185: No. 2, 577-596 (15 Oct 1973).

The Wisconsin Experiment Package filter photometers on OAO-2 were used to obtain data for a carefully selected set of 24 blue (B-V < 0.00) Ap stars and 31 comparison standard B and A dwarfs and giants for a program of relative photometry over the effective wavelength range 1430-4250 Å. The Ap stars observed include members of the Si, Hg-Mn, and Sr-Cr-Eu peculiarity classes, and most of them are too blue in B-V for their published MK spectral classes. The close similarity, deduced from ground-based observations, between the blue Ap stars and normal B stars of similar UBV colors is not maintained in the ultraviolet. The blue Ap stars emit less ultraviolet flux than normal stars of like UBV colors. They are underluminous and cool in effective temperature for their colors. The Hg-Mn stars are less flux-deficient in the ultraviolet, for their UBV colors, than are Si and Sr-Cr-Eu stars. In most cases the ultraviolet flux distribution of a blue Ap star closely resembles that of a normal star of similar MK spectral class. These results are confirmed by ultraviolet spectrophotometry at 10 and 20 Å resolution of the Si star θ Aur, data also obtained with OAO-2. Interesting differences in detail between θ Aur and normal stars are evident in the latter data. The possible role of enhanced ultraviolet opacities in modifying the shape of the emergent flux envelope of an Ap star and in modifying its atmospheric structure, relative to normal B stars, is discussed. (auth)

1054 NEW OBSERVATIONS OF RV TAURI STARS. DuPuy, D.L. (David Dunlap Observatory, University of Toronto, Richmond Hill, Ontario, Canada). Astrophys. J. 185: No. 2, 597-619 (15 Oct 1973).

New photoelectric and spectroscopic observations of RV Tauri stars

have been obtained, and mean visual magnitudes and characteristics of the light and color curves have been derived. Most RV Tauri stars show rather irregular light curves, with successive cycles showing deviations up to several tenths of a magnitude. An analysis of the color excesses in (V–R) indicates the existence of reddening due to circumstellar material. Revised periods are suggested in a number of cases. Attempts were made to determine absolute magnitudes of RV Tauri stars by the following methods: (i) globular–cluster RV Tauri stars; (ii) mean secular and statistical parallaxes; (iii) the application of Wesselink's method (which was unsuccessful); and (iv) luminosity classification spectrograms. A period–luminosity relation is evident. Absolute magnitude methods which depend on observations of apparent magnitudes yield results averaging about 1.5 mag fainter than those methods based on other arguments. This difference is attributed to mostly nonselective absorption in circumstellar material and leads to visual absolute magnitudes of –5 to –6 inside the circumstellar shells. (auth)

1055 FREQUENCY-QUADRATURE PERTURBATIONS IN RADIATIVE-TRANSFER THEORY. Cannon, C.J. (Department of Applied Mathematics, The University of Sydney). Astrophys. J. 185: No. 2, 621-630 (15 Oct 1973).

A new numerical method is presented for solving the equation of radiative transfer for spectral–line formation. This method enables the integral over frequency to be represented by a quadrature sum of lower order than that previously used to obtain solutions of the required accuracy. In particular, it is found that the method is best suited to slab geometry where, using only one point quadrature over frequency, results are obtained at least as accurate as those obtained from other existing numerical methods. Although more frequency–quadrature points are necessary in semi–infinite situations, the method gives sufficiently accurate solutions for ϵ ($\sim C_{UL}/A_{UL}$) of order 10^{-4}, for example, with just three quadrature points. Thus, since at least seven quadrature points have been required in the past for numerical solution of even the most simple problem in spectral–line formation theory, the computer time and storage required for this new method is significantly reduced. Further, the technique is quite general and may be used in any radiative–transfer problem involving integration over frequency. It may also be used, if so desired, in conjunction with other methods and may therefore be easily incorporated into existing computer programs.
programs. (auth)

1056 THE EFFECT OF INTRINSIC SPIN ON NEUTRON STARS IN THE EINSTEIN–CARTAN THEORY OF GRAVITY. Kerlick, G.D. (Joseph Henry Laboratories, Princeton University). Astrophys. J. 185: No. 2, 631-633 (15 Oct 1973).

The relative size of the surface deformations of a neutron star due to (1) rotation, (2) magnetic dipole force, and (3) the gravitational force due to intrinsic spin (Cartan torsion) are estimated. The size of the torsion effect is found to be many orders of magnitude less than the magnetic dipole interactions, and hence unobservable for neutron stars. (auth)

1057 PERTURBATIONS OF A ROTATING BLACK HOLE. I. FUNDAMENTAL EQUATIONS FOR GRAVITATIONAL, ELECTROMAGNETIC, AND NEUTRINO–FIELD PERTURBATIONS. Teukolsky, S.A. (California Institute of Technology, Pasadena). Astrophys. J. 185: No. 2, 635-647 (15 Oct 1973).

This paper derives linear equations that describe dynamical gravitational, electromagnetic, and neutrino–field perturbations of a rotating black hole. The equations decouple into a single gravitational equation, a single electromagnetic equation, and a single neutrino equation. Each of these equations is completely separable into ordinary differential equations. The paper lays the mathematical groundwork for later papers in this series, which will deal with astrophysical applications: stability of the hole, tidal friction effects, superradiant scattering of electromagnetic waves, and gravitational–wave processes. (auth)

1058 PERTURBATIONS OF A ROTATING BLACK HOLE. II. DYNAMICAL STABILITY OF THE KERR METRIC. Press, W.H.; Teukolsky, S.A. (California Institute of Technology, Pasadena). Astrophys. J. 185: No. 2, 649-673 (15 Oct 1973).

If unstable, a rotating black hole would spontaneously radiate gravitational waves and evolve dynamically to some new (unknown) final state. This paper tests the dynamical stability of rotating holes by numerical integration of the separable perturbation equations for the Kerr metric. No instabilities are found in any of the dozen or so lowest angular modes tested, for any value of specific angular momentum $0 \leq a < M$. Even in the limit $a \to M$, the hole appears to be stable. These stability results add credibility to the use of the Kerr metric in detailed astrophysical models. A numerical technique for preserving accuracy on an asymptotically small solution to an ordinary differential equation in the presence of an asymptotically large one is described. (auth)

1059 THE STABILITY OF SCALAR PERTURBATIONS OF A KERR–METRIC BLACK HOLE. Detweiler, S.L.; Ipser, J.R. (University of Chicago). Astrophys. J. 185: No. 2, 675-683 (15 Oct 1973).

Weak perturbations assumed to obey the scalar wave equation $\Box\Phi = 0$ in the exterior of a Kerr-metric black hole are studied. Attention is focused on normal modes, which have time–dependences of the form $e^{i\omega t}$. Analytic and numerical analyses reveal that there are no physically acceptable normal modes that are unstable, i.e., that have frequencies ω in the lower half of the complex plane. Hence there is no indication at this level of approximation that Kerr black holes are unstable. (auth)

1060 A VARIATIONAL PRINCIPLE AND A STABILITY CRITERION FOR THE NONRADIAL MODES OF PULSATION OF STELLAR MODELS IN GENERAL RELATIVITY. Detweiler, S.L.; Ipser, J.R. (University of Chicago). Astrophys. J. 185: No. 2, 685-707 (15 Oct 1973).

Small nonradial perturbations of spherical stellar models in general relativity are studied. A variational principle for the normal modes of nonradial pulsation with $l \geq 2$ is derived. In this principle, an expression for the squared frequency is stationary with respect to arbitrary variations of three independent dynamical variables if and only if the variations are carried out about the eigenfunctions of a normal mode. The stationary value of the frequency is the associated eigenfrequency. For normal modes with purely outgoing radiation, the variational principle is modified to yield an approximation scheme for computing first and real part and then the imaginary part of an outgoing eigenfrequency with small imaginary part. Associated with the variational principle is an energy–like quantity that obeys a conservation law. It is shown that a model has no neutral, or zero–frequency, modes if the density decreases outward monotonically and if the relativistic Schwarzschild discriminant is nonzero. If the discriminant is actually positive, the outgoing normal modes are atable. (auth)

1061 ON THE TWO OOSTERHOFF GROUPS OF GLOBULAR CLUSTERS. van Albada, T.S. (Kapteyn Laboratory, Groningen University); Baker, N. Astrophys. J. 185: No. 2, 477-498 (15 Oct 1973).

The observational evidence leading to the classification, following Oosterhoff, of globular clusters containing RR Lyrae stars into two distinct groups, is summarized and discussed in the light of results of stellar–evolution theory and pulsation theory. The dichotomy is caused, at least in part, by a dichotomy in the "transition period" between the type ab and type c stars which reflects a difference in effective temperature at the transition point. When this difference is accounted for, there remains a smaller average difference between the groups, although no longer a clear dichotomy, that is probably a mass and luminosity effect. If this remaining difference is interpreted as a luminosity effect the average difference in luminosity between the two Osterhoff groups is at most 0.1 mag. It is suggested that Christy's theoretical relationship between transition period and luminosity cannot be valid, at least not for clusters of different Oosterhoff groups. It is conjectured that the transition–temperature dichotomy may be a reflection of different predominant directions of evolution through the instability strip, accompanied by a hysteresis effect in the pulsation. (auth)

1062 THE EMISSION–LINE SPECTRUM OF N49. Osterbrock, D.E.; Dufour, R.J. (Washburn Observatory, University of Wisconsin, Madison). Astrophys. J. 185: No. 2, 441-451 (15 Oct 1973).

Line identifications and photographically determined relative emission–line intensities are given for N49, a supernova remnant in the Large Magellanic Cloud. The measured line intensities agree qualitatively with supernova–remnant models calculated by Cox, and disagree strongly with measured line intensities in photoionization nebulae. The measured line intensities of heavier ions not included in Cox's models agree qualitatively with calculations from simple approximate extensions of the models. The main features resulting from the conversion of kinetic energy into heat followed by recombination and radiative cooling also appear to be observed in the nuclei of many emission–line galaxies. (auth)

1063 THE CONSEQUENCES OF GRAINS IN THE ATMOSPHERES OF LATE–TYPE STARS. II. THE THERMODYNAMICS OF GRAINS IN A CHROMOSPHERE. Jennings, M.C. (Steward Observatory, University of Arizona, Tucson). Astrophys. J. 185: No. 1, 197-207 (1 Oct 1973).

The temperature–structure changes necessary to quench chromospheric emission are studied, and it is found that a lessening of the overall temperature or a reduction of the amount of hot material will suffice. The equations governing the thermodynamics of a simplified chromospheric gas and of grain particles immersed in the gas are derived. From these equations it is shown that a grain's internal temperature depends entirely on the local radiation temperature and that the gas cools if the grain density is sufficiently high. The time required for cooling is found to be of the order of the time needed for the average gas particle to collide with a grain. (auth)

1064 ON THE ABUNDANCE OF LITHIUM IN RED GIANTS OF INTERMEDIATE MASS. Iben, I. Jr. (University of Illinois). Astrophys. J. 185: No. 1, 209-211 (1 Oct 1973).

A quantitative investigation of a mechanism for producing ^{7}Li in the envelope of a star that is undergoing thermal oscillations gives disappointing results. At maximum, the surface abundance by mass of ^{7}Li is only 3×10^{-11} when the mass of the carbon–oxygen core is 0.95 $M_\odot$. However, a projection of current results suggests that the maximum of the surface ^{7}Li abundance increases with each thermal pulse. A substantial surface abundance of ^{7}Li may develop before a supernova event occurs. Surface ^{7}Li will appear at maximum abundance during the thermal pulse in the helium shell and slowly disappear during the long interpulse phase. (auth)

1065 THE $^{12}C/^{13}C$ RATIO IN STELLAR ATMOSPHERES. I. ALPHA SERPENTIS AND ALPHA BOOTIS. Day, R.W.; Lambert, D.L.; Sneden, C. (McDonald Observatory and Department of Astronomy, The University of Texas, Austin). Astrophys. J. 185: No. 1, 213-228 (1 Oct 1973).

High–resolution photoelectric scans of portions of the (2–0) band of the CN red system have been analyzed to obtain the isotopic abundance ratio for two K giants. The results are $^{12}C/^{13}C=12\pm2$ for α Serpentis and 7.2 ± 1.5 for α Bootis. An attempted independent determination of the $^{12}C/^{13}C$ ratio for α Ser from the CH λ4200 band is discussed briefly. The marked enhancement of the isotope ^{13}C relative to the solar–system abundance ($^{12}C/^{13}C=89$) is in qualitative agreement with recent theoretical ideas on mixing in red giants. (auth)

1066 INFRARED EMISSION FROM UNUSUAL BINARY STARS. Woolf, N.J. (University of Minnesota). Astrophys. J. 185: No. 1, 229-237 (1 Oct 1973).

Infrared emission between 2 and 22 microns has been photometrically observed for nine binary stars, ϵ Aur, ζ Aur, W Cep, Z And, UV Aur, ν Sgr, HD 30353 (KS Per), η Gem, and RZ Cnc. A model is developed for ϵ Aur. There are indications of free–free emission in some objects without H emission lines, confirming a suggestion by Dyck and Milkey. The continuum in ν Sgr is interpreted as due to a shell of graphite. A peak resembling that in carbon stars occurs near 11 μ. Limited systematics of this peak suggest that it correlates with high nitrogen abundance, and is probably due to Si_3N_4. (auth)

1067 HIGH TIME RESOLUTION STUDIES OF UV CETI. Bopp, B.W.; Moffett, T.J. (Department of Astronomy, The University of Texas at Austin, and McDonald Observatory). Astrophys. J. 185: No. 1, 239-252 (1 Oct 1973).

Simultaneous high–speed photometry and time–resolved spectroscopic observations of two large flares in UV Ceti are presented. Marked spectroscopic and photometric differences between the two flares are noted, and spectroscopic and photometric changes during the flares are correlated. For the larger flare, spectrophotometry shows the Balmer lines to contribute 16 percent of the flare intensity in the B–bandpass. The larger flare is compared with the theoretical models of Gurzadyan and Kunkel, and significant discrepancies are found. An interpretation in terms of shock–wave propagation is suggested. (auth)

1068 THE ON9 V STAR HD 201345. Lester, J.B. (Smithsonian Astrophysical Observatory, Cambridge, Massachusetts). Astrophys. J. 185: No. 1, 253-264 (1 Oct 1973).

A study of HD 201345 that makes use of model stellar atmospheres shows that the abundances of carbon, nitrogen, and possibly oxygen are abnormal when compared to 10 Lac. The helium, magnesium, and silicon abundances are found to be normal. The most plausible explanation for the observations seems to be the presence of matter on the surface of the star that has been partially processed by the CNO cycle, but the results are not in quantitative agreement with the theoretical predictions. (auth)

1069 AS ERIDANI. Popper, D.M. (Department of Astronomy, University of California, Los Angeles). Astrophys. J. 185: No. 1, 265-275 (1 Oct 1973).

AS Eri is found to consist of an A3 main–sequence star of mass 1.9 $M_\odot$ and a subgiant of mass 0.21 filling its critical Roche lobe. The properties of the A star appear closely similar to those of detached main–sequence stars of similar mass, while the component of small mass conforms to a quasi–stable configuration resulting from mass exchange as predicted by Refsdal and Weigert. Pre–main–sequence contraction appears an unlikely explanation for this component. (auth)

1070 NONRADIAL OSCILLATIONS OF COOLING WHITE DWARFS. Osaki, Y.; Hansen, C.J. (Joint Institute for Laboratory Astrophysics and Department of Physics and Astrophysics, University of Colorado, Boulder). Astrophys. J. 185: No. 1, 277-292 (1 Oct 1973).

The equations for linear adiabatic nonradial oscillations have been solved for cooling white–dwarf models. Periods and eigenfunctions are obtained for the g_2,g_1,f,p_1,p_2, modes of nonradial quadrupole oscillations. Periods of the g_1–mode range from 50 to 200 seconds for typical white–dwarf stars with $M=0.4\sim1.0\ M_\odot$ and $L=10^{-4}L_\odot\sim10^{-2}L_\odot$. It is shown that there exist period–luminosity relations for g–modes along the cooling white–dwarf sequence. The damping of nonradial oscillations due to radiative heat leakage, neutrino losses, and gravitational radiation is studied in the quasi–adiabatic approximation, and all models are found to be pulsationally stable. It is found that the emission of gravitational waves is the most efficient mechanism for the damping of f– and p–modes while radiative heat leakage is the most efficient for g–modes. Damping times range from a few tens of years to about 10^5 years—time scales much shorter than Kelvin or cooling times for white dwarfs. Results are compared with observations of ultrashort–period variables. It is suggested that light variations of HL Tau 76(P=747 s) and G44–32 (P=600 s) may be associated with nonradial g_1 oscillations of white dwarfs with convective envelopes. The importance of gravitational radiation from nova outbursts is also discussed. (auth)

1071 EXPLOSIVE r–PROCESS NUCLEOSYNTHESIS. Schramm, D.N. (Departments of Astronomy and Physics, The University of Texas, Austin). Astrophys. J. 185: No. 1, 293-301 (1 Oct 1973).

Previous r–process calculations were done using constant temperature and neutron density. However, the r–process presumably occurs under dynamic conditions in supernovae. In this work, more realistic, dynamic r–process calculations with time–varying temperature and density are presented. It is shown that these dynamical calculations eliminate the previous need for arbitrary smoothing of the calculated abundances in order to fit the observed r–process abundances. It is also shown that for certain conditions it is possible to make all three observed r–process abundance peaks in the same dynamical event. Previous nondynamical calculations were always forced to have more than one event in order to fit the observed peaks. It is felt that these dynamic calculations are able to remove many of the major uncertainties regarding the r–process. (auth)

1072 POLARIMETRIC APERTURE SYNTHESIS OBSERVATIONS OF FOUR SMALL–DIAMETER SUPERNOVA REMNANTS. Hermann, B.R.; Dickel, J.R. (Vermilion River Observatory, University of Illinois, Urbana, Illinois 61801). Astron. J. 78: No. 9, 879-884 (Nov 1973).

Polarimetric aperture synthesis observations with the highest resolution yet published are presented for the four small–diameter supernova remnants Tycho's SNR, 3C58, the γ–Cygni radio source, and Kepler's SNR. Tycho's SNR has a large–scale shell distribution with considerable fine structure superimposed upon it. The fine structure in the polarization is well correlated with the fine structure in total intensity. The total intensity from 3C58 shows the source to be a smooth filled ellipsoid but the polarized emission is very complex with very sudden changes in both intensity and position angle. This source appears to be similar to the Crab Nebula. A few features are visible in the field of the γ–Cygni source, but most of the structure must be on a large scale and consequently, invisible to the interferometer. Kepler's SNR appears to be a generally thick shell source with a probable elliptical outline. Some features not part of the uniform shell are noted and there appears to be little correlation of the radio emission with the optical features seen in that direction. (auth)

1073 AN EXPANDING SHELL OF NEUTRAL HYDROGEN SURROUNDING THE SUPERNOVA REMNANT HB 21. Assousa, G.E.; Erkes, J.W. (Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C. 20015). Astron. J. 78: No. 9, 885-893 (Nov 1973).

Neutral hydrogen observations were carried out with the National Radio Astronomy Observatory 140–ft telescope in a $6^\circ\times6^\circ$ region centered on the supernova remnant HB 21. The observed features strongly suggest the existence of an expanding neutral hydrogen shell with an expansion velocity of 25 km/sec. The shell is concentric with the continuum source, but is external to it. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

1074 (ESRO–SP–87) X–RAY ASTRONOMY IN THE NEAR FUTURE. Proceedings of a Colloquium Held in Frascati, Italy, May 25–26, 1972. (European Space Research Organization, 92 – Neuilly–sur–Seine (France)). Feb 1973. 191p. (CONF–7205106–).

Eighteen papers were presented at the Colloquium, sixteen of which have been abstracted for NSA. (FR)

For abstracts of individual papers see: 1075–1090.

1075 (ESRO–SP–87, pp 1–18) SURVEY OF CURRENT DEVELOPMENTS IN X–RAY ASTRONOMY. Giacconi, R. (American Science and Engineering, Inc., Cambridge, MA). Feb 1973.

From colloquium on x–ray astronomy in the near future; Frascati, Italy (25 May 1972).

A rough sketch is presented on the known x–ray sky. A detailed description is then given of the observation of a class of galactic sources, the pulsating stars in binary systems, in order to illustrate the progress made from their initial discovery up to the de-

tailed study of their physical parameters. The recent observation of x-ray emission from the great clusters is discussed in order to illustrate how greatly the scope of x-ray astronomy has expanded and how it may further be expanded to give information about objects at cosmological distances. (FR)

1076 (ESRO-SP-87, pp 19-23) OAO-C X-RAY EXPERIMENT. Sanford, P. W. (Mullard Space Science Lab., London). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The OAO-C x-ray experimental arrangement is described. The x-ray experiment is secondary to the main experiment which is an ultraviolet high spectral resolution instrument whose prime aim is to determine the properties of interstellar matter. It is expected that the x-ray experiment can be pointed with an accuracy of better than one arc minute limited to regions which are more than 60 deg from the Sun. (FR)

1077 (ESRO-SP-87, pp 31-50) DESCRIPTION AND PERFORMANCE OF THE THIRD SMALL ASTRONOMY SATELLITE (SAS-C). Mayer, W. (Massachusetts Inst. of Tech., Cambridge). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

It was decided that the SAS-C experiment should be conducted in the form of a group of small experiments, each of which could be pointed at a particular object and used to determine a well-defined x-ray parameter. The SAS-C experiment has thus, the properties of an x-ray observatory. Special attention is given, in the description, to those systems which relate to the HELOS experiment, i.e., the position-determination systems (the star camera and the modulation collimators), and the low-energy systems (the titanium proportional counter, the parabolic concentrators, the filter wheel, proportional counters with propylene windows, and the gas supply system). (FR)

1078 (ESRO-SP-87, pp 51-59) X-RAY EXPERIMENT IN THE ASTRONOMICAL NETHERLANDS SATELLITE (ANS). Heise, J. (Univ. of Utrecht). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The astronomical Netherlands Satellite (ANS) payload consists of three scientific experiments: a soft x-ray experiment for the wavelength region 2 to 55 A, a hard x-ray experiment for the energy range 2 to 40 keV, and a uv photometer for 5 bandwidths of about 100 A between 1500 and 3300 A. The first experiment utilizes a small-area proportional counter at the focus of a ring shaped parabolic flux condenser for the range 44 to 70 A and a large area proportional counter, behind a mechanical collimator, for the ranges 27 to 35 A and 2 to 12 A. The second experiment utilizes two large-area proportional counters having wire-grid collimators, two Bragg crystals, and proportional counter detectors. (FR)

1079 (ESRO-SP-87, pp 61-62) GODDARD COSMIC X-RAY EXPERIMENT FOR OSO-I. Boldt, E. A. (Goddard Space Flight Center, Greenbelt, MD). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The primary objective of the experiment is to utilize proportional counters of multi-anode multi-layer construction to obtain the spectra of X-ray sources and the diffuse background over the band 2 to 60 keV. Instead of using many diverse maneuvers to look at hypothetical x-ray sources, the 1 deg-per-day maneuverability of the spin axis is used. It is programmed well in advance, to obtain the spectra of objects already known to be x-ray sources. A schematic representation of this experiment as configured for the OSO-I wheel and characteristic parameters is presented. (FR)

1080 (ESRO-SP-87, pp 63-75) STELLAR X-RAY POLARIMETRY ON OSO-I. Landecker, P. B.; Novick, R. (Columbia Univ., New York). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The importance of stellar x-ray polarimetry is reviewed. A graphite crystal polarimeter sensitive near 2.6 and 5.2 keV, which has been designed for the OSO-I satellite, is described. The instrument's predicted performance for many stellar x-ray sources is presented, and the fundamental questions that can be resolved with the OSO-I polarimeter are considered. The sensitivity of the instrument is such that, during an observation time of 24 hours, the polarization of the Crab Nebula can be measured with an accuracy of 0.6 percent (1 sigma). (FR)

1081 (ESRO-SP-87, pp 77-93) STELLAR BRAGG CRYSTAL X-RAY SPECTROMETRY ON OSO-I. Landecker, P. B.; Novick, R. (Columbia Univ., New York). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

A high sensitivity crystal x-ray spectrometer for use on the Orbiting Solar Observatory (Mission I) satellite is described. This instrument will be used to obtain both solar and stellar spectra in the energy range 1 to 8 keV. In the stellar mode the shape of the continua, the strength of lines, and the strength of recombination and absorption edges will be determined. If lines or edges are detected, such data will provide direct evidence regarding the physical conditions in the emitting and absorbing regions. If only upper bounds are established, the data can be used to constrain theoretical models. In any case, precise continuum shapes will be established for a number of the brighter x-ray sources. Numerical estimates of the sensitivity of the instrument for these various purposes are given. (FR)

1082 (ESRO-SP-87, pp 95-103) CORSA JAPANESE SATELLITE. Oda, M. (Tokyo Univ.). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

Some technical details of CORSA I (which will not be flown due to delays) are described along with the revised design of the flight model which is presently underway. (WDM)

1083 (ESRO-SP-87, pp 105-110) COSMIC X-RAY EXPERIMENTS SELECTED FOR OSO-J. Culhane, J. L. (Univ. Coll., London). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

X-ray astronomy at energies below 2 keV is becoming increasingly important. Three low energy x-ray experiments have been tentatively selected for the OSO-J mission for a possible launch in 1973. Two experiments are designed to study discrete sources and the diffuse component of soft x-radiation in the x-ray and xuv energy range 0.01 to 2.0 keV with the aid of grazing incidence optics. A third instrument provides images of its fields of view with the aid of a Fresnel mask. (FR)

1084 (ESRO-SP-87, pp 111-114) DESCRIPTION OF NRL HEAO-A EXPERIMENT. Shulman, S. D. (Naval Research Lab., Washington, DC). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The primary purpose of the NRL experiment on the HEAO-A satellite is to produce a high-sensitivity map of cosmic x-ray sources. In addition to this primary goal, it will also yield spectral data over the energy range 0.2 to 150 keV and information on source variability with a time resolution of better than 1 msec. (WDM)

1085 (ESRO-SP-87, pp 115-126) INTEGRATED MODULATION COLLIMATOR EXPERIMENT ON HEAO-A FOR OBSERVATION OF X-RAY SOURCES IN THE ENERGY RANGE 1 TO 15 keV. Spada, G. (Massachusetts Inst. of Tech., Cambridge). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The experiment described is aimed at determining the position and size of cosmic x-ray sources in the energy range 1 to 15 keV. It is based on the use of a pair of scanning modulation collimators and four rotating modulation collimators. Some characteristics of the performance of the system in flight are given: the celestial scan mode, typical stability and pointing requirements, the modulation collimator response, and detector efficiency. Correlation maps for Cyg X-1, GX349+2, and GX340+0, obtained during a rocket flight are presented. (FR)

1086 (ESRO-SP-87, pp 127-139) HELOS SCIENTIFIC MISSION AND ITS EXPERIMENTAL PACKAGE. Pounds, K. A. (Univ. of Leicester, Eng.). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The characteristics of the Helos project are such that, apart from the occultation observations which require a small fraction of the observing time, high-sensitivity temporal and spectral observations can be made in continuous observation over selected areas of the sky (offset mode). The objectives of the mission are centered on the location, identification, and understanding of the nature of x-ray sources. A precise determination of the position and size of a selected number of sources can be obtained by observation of lunar occultation. The specific measurements that can be made with Helos on a number of known galaxies and extragalactic sources are discussed. Performance figures on position, size, sensitivity, and time-resolution are given. (FR)

1087 (ESRO-SP-87, pp 155-162) BRAGG CRYSTAL SPECTROMETER FOR HEAO-B X-RAY ASTRONOMY EXPERIMENT. Angel, J. R. P.; Woodgate, B. E. (Columbia Univ., New York). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The instrument to be carried by the HEAO-B satellite consists of two Bragg crystal spectrometers designed to make measurements with high spectral resolution in the energy range from about 0.1 to 10 keV. No sharp spectroscopic features have yet been detected directly in x-ray astronomy other than emission lines in the Sun. Therefore, the objectives and design criteria of this instrument are based on the theoretical models of the different types of extrasolar x-ray sources. From the point of view of instrumental technique, it is convenient to divide these into point or stellar sources, whose radiation is accurately parallel (<1 arc min divergence), and diffuse sources, and to consider the possible spectral features of each type. (FR)

1088 (ESRO-SP-87, pp 163-169) HEAO-B X-RAY EXPERIMENTS NONDISPERSIVE SPECTROSCOPY. Boldt, E. (Goddard Space Flight Center, Greenbelt, MD). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The launch of HEAO-B is estimated to take place in 1977. The current performance capabilities of the spacecraft as estimated by the spacecraft contractor, TRW, are presented. The usual scan period is anticipated to be 10 minutes. The capability of the spacecraft allows for a scan period between 10 and 50 minutes, and the rotation rate has a stability of 0.05% at the 10 minute period. The accuracy with which the spin axis can be pointed is 3 arc minutes; the jitter in the scan mode is less than 1.5 arc seconds per second and the repeatability of the scan from one to the next is ±22 arc seconds. In the pointed mode, the accuracy of pointing is estimated to be better than 3 arc minutes and the jitter less than ±0.2 arc second per second with a holding stability of 20 arc seconds under optimum conditions (meaning that the Sun is available, and also one star). As far as maneuvers from one target to another, the slew rate can be as great as 0.6 degree per second, which is the rate corresponding to the shortest period of scan (10-minute period). The HEAO-B spacecraft has four x-ray and gamma-ray experiments in addition to two charged cosmic-ray experiments. (FR)

1089 (ESRO-SP-87, pp 171-180) HEAO-C (LOXT) MISSION. Giacconi, R. (American Science and Engineering Inc., Cambridge, MA). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The HEAO-C mission contains at present two major experiments: the first (LOXT) was designed by a consortium of institutions in the USA, and the second by a joint British and USA group. After a brief introduction on the use of focusing optics in x-ray astronomy, a brief description of LOXT is given. The principal observations in x rays up to now have been surveys which reveal the existence of discrete sources, the distribution of the background on a scale of degrees, coarse measurements of the spectral shape of the x-ray emission, and observations of variability on a limited time scale. In addition, some detailed measurements of individual objects have been made, such as the precise location of a few objects, and a search for spectral lines and polarization in isolated sources, and, of course, the very exciting study of temporal variations by Uhuru. (FR)

1090 (ESRO-SP-87, pp 181-182) HEAO-C SOFT X-RAY TELESCOPE. Sanford, P. W. (Mullard Space Science Lab., London). Feb 1973.

From colloquium on x-ray astronomy in the near future; Frascati, Italy (25 May 1972).

The soft x-ray telescope and instrumentation described here were selected by NASA. Further developments on the optics and position sensitive detectors are envisaged. (FR)

1091 ARE BINARY SYSTEMS INVOLVED IN SUPERNOVA EXPLOSIONS ALWAYS DISRUPTED. Sutantyo, W. (Univ., Amsterdam). Nature (London); 248: No. 5445, 208-209(15 Mar 1974).

It is stated that no known pulsar is a member of a binary system. Two questions are discussed—(1) are pulsars the result of supernova explosions, (2) have explosions that occurred in binary systems disrupted the systems in most cases. The discovery of the two x-ray "pulsars" Cen X-3 and Her X-1 and other compact x-ray sources in binary systems appears to be an argument against (2) if it is believed that (1) is also valid for compact x-ray sources, and it is shown that (2) is untenable from the point of view of present theories of close binary evolution. (UK)

1092 SEARCH FOR RADIO EMISSION FROM FAINT VARIABLE STARLIKE OBJECTS. Bridle, A.H. (Astronomy Group, Department of Physics, Queen's Univeristy at Kingston, Ontario, Canada); Fomalont, E.B. Astron. J. 79: No. 1, 6-7 (Jan 1974).

A high sensitivity search for 2695- and 8085-MHz radio emission from optically-variable quasar candidates has had negative results. (auth)

1093 VERY LONG BASELINE INTERFEROMETRIC OBSERVATIONS OF THE H_2O SOURCES IN W49 N, W3(OH), ORION A, AND VY CANIS MAJORIS. Moran, J.M. (Smithsonian Astrophysical Observatory, Cambridge, Massachusetts); Papadopoulos, G.D.; Burke, B.F.; Lo, K.Y.; Schwartz, P.R.; Thacker, D.L.; Johnston, K.J.; Knowles, S.H.; Reisz, A.C.; Shapiro, I.I. Astrophys. J. 185: No. 2, 535-567 (15 Oct 1973).

Observations of four galactic H_2O sources were made in 1970 June and 1971 February and March at 1.35-cm wavelength with interferometers having fringe spacings between 0".0008 and 0".01. The features in the spectrum of W49 N between −16 and +12 km s^{-1} were all unresolved and apparently smaller than 0".0005 (1.1×10^{14} cm) in diameter (uniform disk model). The features were distributed over an area of about 1" × 1" ($2\times2\times10^{17}$ cm) and clumped into three regions. Differences in the spatial distribution were observed among the three measurement periods. The H_2O emission regions were coincident, within 5", with the OH emission source. The five features in the spectrum of W3(OH) between −52 and −47 km s^{-1} were all unresolved, with upper limits of 0".002(0.7×10^{14} cm) in diameter. The emission region had dimensions 2"×0".2($0.8\times0.08\times10^{17}$ cm). The features in the Ori A source had apparent sizes between 0".0008(0.6×10^{14} cm) and 0".01(8×10^{14} cm) and were spread over an area of 30" ×30" ($2\times2\times10^{17}$ cm). Changes in the spatial distribution occurred between observations. The two strongest features in VY CMa were unresolved and smaller than 0".002(3×10^{13} cm) and were separated by 0".15(0.2×10^{16} cm). The emission region in VY CMa was an order of magnitude smaller in linear dimension than were those of the other three sources and probably has significantly different physical conditions. Some of the interferometric spectra of W49 N and Ori A seem consistent with the presence of hyperfine structure. (auth)

1094 THE RELATIVISTIC ROCHE PROBLEM. I. EQUILIBRIUM THEORY FOR A BODY IN EQUATORIAL, CIRCULAR ORBIT AROUND A KERR BLACK HOLE. Fishbone, L.G. (Center for Theoretical Physics of the Department of Physics and Astronomy, University of Maryland, College Park). Astrophys. J. 185: No. 1, 43-67 (1 Oct 1973).

Bodies in orbit around Kerr black holes will experience tidal gravitational forces. A study of the equation of geodesic deviation, referred to reference frames fixed in such bodies, reveals the nature of these forces. We here perform this analysis for all circular, equatorial, geodesic orbits of the Kerr metric whose mass parameter M and angular-momentum parameter Ma satisfy $a \leq M$ (geometrical units). Free-particle motion, which the deviation equation describes, is simple harmonic in the direction perpendicular to the equatorial plane, and we demonstrate the relation between the angular frequency of this simple harmonic motion and the circular orbit frequency. The equation for free-particle motion leads to a generalized Euler equation that describes fluid flow in the orbiting reference frames. We employ the latter to study the conditions for equilibrium of infinitesimal, incompressible, homogeneous, self-gravitating fluid bodies in circular, equatorial, geodesic motion. Because the potential in the equation depends only quadratically on the local coordinates, ellipsoidal figures of equilibrium are possible. For each possible orbit determined by the Kerr angular momentum Ma and the orbit radius r, a family of ellipsoids parametrized by the fluid density ρ is in equilibrium. A minimum possible density characterizes each family; this is the Roche-limiting density for the orbit. For fluid bodies in stable circular orbits, the Roche limit is qualitatively like that in Newtonian situations; at the last stable, circular, equatorial orbit Kerr metric, where r is a specified function of M and of a, equilibrium bodies must satisfy $[M/(\pi\rho r^3)] \leq 0.0664$. For fluid bodies in the highly energetic, unstable circular orbits near the photon orbits, the fluid density required for the existence of a body in equilibrium is magnified by the square of its energy-at-infinity per unit mass. Subject headings: binaries—black holes—gravitation—hydrodynamics—relativity (auth)

1095 ON THE EXTENDED LOW STATE OF HZ HERCULIS. Whelan, J. (Steward Observatory, University of Arizona, and Institute of Astronomy, Cambridge). Astrophys. J. Lett. 185: No. 3, L127-L130 (1 Nov 1973).

The parameters of the HZ Her and Her X-1 X-ray binary system are derived by solving the "ellipsoidal variable" type light curve which HZ Her shows during an extended low state. The inclination angle is near 90°. An observational test to determine whether Her X-1 is a white dwarf or a neutron star is suggested. (auth)

1096 OBSERVATION OF H 42α IN ORION A. Waltman, W.B.; Waltman, E.B.; Schwartz, P.R.; Johnston, K.J. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D. C.); Wilson, W.J. Astrophys. J. Lett. 185: No. 3, L135-L137 (1 Nov 1973).

The H 42α (85.6884 GHz) line has been observed in Orion A and found to be stronger in intensity than non-LTE theory predicts for a spherically symmetric model H II region. (auth)

1097 INFRARED BRIGHTNESS DISTRIBUTION OF DUSTY H II REGIONS. Wright, E.L. (Harvard College Observatory, Cambridge, Massachusetts). Astrophys. J. 185: No. 2, 569-572 (15 Oct 1973).

The infrared spectra and brightness distributions of dusty H II regions are considered with the effects of a large depletion of dust inside the ionized volume and the stellar radiation longward of 912 Å included. A natural separation of near- and far-infrared emitting regions is found: the far-infrared is produced in a circumnebular dust shell while the near-infrared is produced within the ionized volume by dust heated by Lα. (auth)

1098 THE EFFECT OF THE GUM NEBULA ON SOFT X-RAYS FROM GALACTIC SOURCES. Mack, J.E. (Physics Department, University of Houston). Astrophys. J. 185: No. 1, 323-326 (1 Oct 1973).

The effect of He ionization in the Gum Nebula on the observed soft X-ray flux from galactic sources is investigated. A strong enhancement is predicted if a substantial fraction of He in the nebula is doubly ionized. Because of the high recombination rate of He III, this effect can be used to distinguish between "instantaneous" ionization models of the nebula, and models where the ionization mechanism persists for $\sim 10^4$ years. A preliminary calculation, based on published results of a single observation, supports a nebula model in which the fraction of He III is low. (auth)

1099 LONG-TERM X-RAY OBSERVATIONS OF SCORPIUS X-1 BY OSO-III. Pelling, R.M. (University of California, San Diego). Astrophys. J. 185: No. 1, 327-334 (1 Oct 1973).

The X-ray telescope on the Third Orbiting Solar Observatory (OSO-III) has provided observations of Sco X-1 in the energy range 7.7-22 keV from 1967 May 19 to June 13. Flux measurements in the 7.7-12.5 keV channel are available having statistical uncertainty between 10 and 20 percent for each of about 10 2-minute integration periods during a typical 90-minute orbital period. From May 19 to June 13 Sco X-1 exhibited a well-defined "quiescent" emission state with variations limited to about ± 25 percent around the mean flux value of 1.0 counts cm^{-2} s keV at 9 keV. Superimposed on this quiescent state are periods of "flaring" during which the intensity may double in a few minutes. During four instances of optical flaring for which X-ray coverage is available, the X-ray and optical emissions showed similar behavior. For the quiescent state, the variation of the 7.7-22.5 keV number flux with optical brightness is less than 0.21 ± 0.09 counts cm^{-2} s keV magnitude for the range B = 12.7-13.5. (auth)

1100 TIDAL GRAVITATIONAL RADIATION. Mashhoon, B. (Joseph Henry Laboratories, Princeton University). Astrophys. J. 185: No. 1, 83-86 (1 Oct 1973).

The gravitational radiation emitted by a star tidally deformed in the field of a black hole is considered in the context of a very simple model for the star and the weak-field approximation for the flux of the radiation. The results suggest that tidal gravitational radiation may be important in some cases of astrophysical inte.est. Subject headings: black holes—gravitation—relativity (auth)

1101 SPECTRA OF SOME OHIO RADIO SOURCES: LIST IV. Andrew, B.H. (National Research Council of Canada, Ottawa); Ehman, J.R.; Gearhart, M.R.; Kraus, J.D. Astrophys. J. 185: No. 1, 137-144 (1 Oct 1973).

Flux densities of 37 radio sources from the Ohio catalog have been measured at six frequencies between 612 MHz and 10.7 GHz. Positions accurate to about 15″ are also given. Sixteen of the sources have spectra which indicate that they are potential variable sources. Subject headings: radio sources—spectra, radio (auth)

1102 THE SPECTRUM OF OJ 287. Visvanathan, N. (Hale Observatories, Carnegie Institution of Washington, California Institute of Technology). Astrophys. J. 185: No. 1, 145-152 (1 Oct 1973).

The absolute-energy-distribution observations of OJ 287 were obtained with 20-Å bandwidth in blue and 40-Å in red from 3300 to 10,000 Å, on 1972 January 18, 19, 20, and 21. The continuum is featureless, without any absorption or emission lines. Further, the continuum can be represented by a straight line with a slope of 1.248 in log F_ν versus log, plot. Polarization observations on January 19, in the wavelength range 3300-8000 Å, show that the continuum is linearly polarized and P and θ are independent of wavelength. The above observations are interpreted to indicate that the continuum of OJ 287 is of synchrotron origin. A theoretical synchrotron spectrum based on a simple model of high-energy electrons having a single power-law energy distribution is computed and found to fit the observed spectrum of OJ 287 from 3.5 mm to visible wavelengths. Subject headings: infrared sources—polarization—radio sources—synchrotron radiation (auth)

Solar Phenomena

Refer also to abstracts 1081 and 2420.

1103 INTERPRETATION OF SOLAR HARD X-RAY BURST POLARIZATION MEASUREMENTS. Brown, J. C.; McClymont, A. N.; McLean, I. S. (Glasgow Univ.). Nature (London); 247:: No. 5441, 448-449(15 Feb 1974).

Reference is made to Tindo and others (Solar Phys. 14: 204 (1970); 24: 429 (1972); 27: 426 (1972)) who reported the first observations of polarization of solar flare emission in the hard x-ray band around 15 keV, and attempted to interpret them. Their results depended, however, on the removal of systematic differences in sensitivity of the detectors used in the polarimeters employed by calibration on an "unpolarized" source. It is stated here that these results are erroneous since the calibration was based on the assumption that the hard x-ray flux from the flare itself tends to zero polarization in its final stages of decay. This assumption is invalidated by the presence, in the total flux, of a large polarized contribution from photospheric albedo photons. Consideration is given as to how much this calibration error may affect interpretation of the results in terms of flare particles, and it is suggested how further theoretical work, combined with results using a laboratory calibrated polarimeter, could yield information on the spatial location of hard x-ray flares as well as on their true polarization. It is stated that hard x-ray polarization measurements play a key role in the formulation of flare theories, since the degree and plane of polarization indicate the velocity distribution of the bremsstrahlung source electrons, and in particular whether they stream along the flare field lines or are magnetically trapped, thus giving an insight into the flare particle acceleration mechanism. Furthermore, observations of the variation of polarization with photon energy should provide a means of determining whether the photon energy above which non-thermal electrons, rather than the multi-temperature flare plasma, constitutes the dominant x-ray production mechanism. This question is fundamental to the overall energetics of flares, due to the characteristically steep electron spectra involved. Models of hard x-ray flares are discussed. (UK)

1104 PROPAGATION OF PARTICLES FROM SOLAR FLARES IN A MEDIUM WITH A SHARPLY CHANGING DIFFUSION COEFFICIENT. Toptygin, I. N. (Leningrad Polytechnical Inst.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 341-345(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 393-398(1973).

The motion of particles emitted during a solar flare is discussed when the transport range is large in a region of size a ≥ 1 AU surrounding the Sun, and small outside this region. It is shown that damped oscillations of density and flow anisotropy of particles of a given energy with period ~a/v, where v is the particle velocity, may be recorded at the Earth's orbit. (auth)

1105 POSSIBLE COSMIC DUST ORIGIN OF TERRESTRIAL PLUTONIUM-244. Sakamoto, K. (Kanazawa Univ., Japan). Nature (London); 248: No. 5444, 130-132(8 May 1974).

The reported discovery of ^{244}Pu in the rare-earth ore bastnaesite, in California, has raised the question as to whether this "extinct" nuclide, with a half-life of 82 my, is part of an almost extinct nuclide group or whether it was carried to Earth from a cosmic-ray source before formation of the ore. Three possibilities are here discussed: (1) survival of primaeval ^{244}Pu, (2) influx as a heavy cosmic-ray component, and (3) inflow as a cosmic-dust component from supernova remnants. Difficulties are found with the first two possibilities, but calculations give some support to (3). The ^{129}Xe excess reported in an old Australian iodyrite, AgI, is also not inconsistent with such an hypothesis. An experimental search for ^{244}Pu in deep sea sediments would be interesting, and such studies are contemplated. (UK)

1106 CHARACTERISTICS OF FISSION TRACKS IN ZIRCON: APPLICATIONS TO GEOCHRONOLOGY AND COSMOLOGY. Krishnaswami, S. (Tata Inst. of Fundamental Research, Bombay); Lal, D.; Prabhu, N.; Macdougall, D. Earth Planet. Sci. Lett.; 22: No. 1, 51-59(Apr 1974).

A simple method is described for nearly isotropic revelation of fission tracks in zircon. The etchant is an equivolume mixture of 48% HF and 98% H_2SO_4; etching is carried out under pressure at 150 to 180°C. For fossil track densities above $\sim 5 \times 10^6$, the etching time is strongly anticorrelated with track density. The total etchable fission fragment track length (2 fragments) is 11 ± 0.5 μm. The length distribution is sharply peaked; the standard deviation in different samples is $\pm$ (0.7 – 0.8) μm. Thermal annealing studies indicate a lower activation energy for track fading than was previously reported using a phosphoric acid etchant. A practical chemical dissolution method is described for quantitatively recovering zircon crystals from rock samples; this method should

find application in fission track dating of even zircon poor rocks. (auth)

1107 SPECTROMETER FOR STUDYING SOLAR GAMMA RADIATION BURSTS IN THE 0.03 TO 0.3 MeV ENERGY RANGE. Kudryavtsev, M. I.; Likin, O. B.; Melioranskii, A. S.; Savenko, I. A.; Smirnov, V. V.; Shamolin, V. M. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 352-356 (1973).

Translated from Geomagn. Aeron.; 13: No. 3, 406-410(1973).

Measurement of solar x rays and γ radiation involves a number of operational aspects that should be taken into consideration in the development of instruments for such measurements. An SGL-1 γ-spectrometer, which was used to record bursts of solar γ-radiation on the Prognoz automatic station is described. Basic principles of the design of the instrument are presented, a description of the operation of its various units is given, and the basic physical-technical characteristics are described. (auth)

1108 LARGE SCALE INHOMOGENEITIES IN THE SECTOR STRUCTURE OF THE SOLAR WIND. Shabanskii, V. P.; Smirnova, L. P. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 479-484(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 561-568(1973).

An azimuthally inhomogeneous solar wind is investigated. The inhomogeneous distribution of plasma velocity and density and of the solar magnetic field in the plane of the ecliptic is represented as a small perturbation from the average values of these parameters. The general case of propagation of magnetohydrodynamic disturbances in an inhomogeneous plasma with density decreasing along the radius and with a decreasing magnetic field with spiral-like lines of force is analyzed. The effect of average values of the solar magnetic field, of plasma flow velocity, and of the speed of rotation of the Sun on the development of a disturbance of gas-kinetic plasma and field parameters is investigated. The results of numerical computations of the amplitudes and phase relations of these disturbances are presented. (auth)

1109 INTERACTION OF FLOWS WITH DIFFERENT VELOCITIES IN THE SOLAR WIND. Shabanskii, V. P.; Shister, A. R. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 485-488(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 569-573(1973).

Plasma outflow from a rotating source, identified with the Sun, is analyzed in the framework of single-fluid magnetohydrodynamics. A general and a particular solution are given for boundary conditions that depend arbitrarily on time and that are stationary in a rotating coordinate system, respectively, in the approximation of free scattering. An example is given of an exact solution with allowance for pressure in the case of a polytropic exponent $\gamma = 3$. (auth)

1110 SHOCK-WAVE PROPAGATION IN INTERPLANETARY SPACE. I. Krymskii, G. F.; Transkii, I. A. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 489-493(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 574-579(1973).

The propagation of a shock wave produced by a noncentral point explosion is investigated. The geometric characteristics of the shock front are found and the shock-wave parameters at the orbit of the Earth are estimated. (auth)

1111 THE FORMATION OF RESONANCE LINES IN MULTIDIMENSIONAL MEDIA. II. RADIATION OPERATORS AND THEIR NUMERICAL REPRESENTATION. Jones, H.P. (NASA-GSFC Laboratory for Solar Physics, New Mexico Station, Albuquerque); Skumanich, A. Astrophys. J. 185: No. 1, 167-181 (1 Oct 1973).

A general integral-operator representation of radiative transfer in an atmosphere whose properties vary in more than one spatial dimension is developed together with well-posed procedures for its discrete numerical representation. This methodology is applied to the "non-LTE" excitation equilibrium of a two-level impurity species, i.e., to the formation of a resonance absorption line. The radiation operator that appears in the excitation equation is converted into a finite but large matrix by means of a suitably selected finite set of basis functions. This matrix-excitation equation is inverted directly to yield the excitation state and, hence, the impurity absorption characteristics of the plasma. Illustrative applications to the formation of a resonance line in a constant-density plasma with several types of two-dimensional temperature structures are presented. (auth)

1112 THE FORMATION OF RESONANCE LINES IN MULTIDIMENSIONAL MEDIA. III. INTERPOLATION FUNCTIONS, ACCURACY, AND STABILITY. Jones, H.P. (Laboratory for Solar Physics, NASA/GSFC New Mexico Station, Albuquerque). Astrophys. J. 185: No. 1, 183-196 (1 Oct 1973).

The accuracy and stability for several specific representations of the integral-operator technique presented in Paper II (Jones and Skumanich 1973) are discussed. Solutions are tested against independently calculated results for an effectively thin "embedded slab." It is found that the cardinal interpolation functions for approximating the source function along characteristics must be "local," must give accurate representation of a variety of functions and their second derivatives on coarse, irregular grids, and must be compatible with interpolation functions used to map functions of spatial position to functions of path length. Cubic splines appear to meet these requirements and give good overall results. (auth)

1113 RESONANCE-LINE TRANSFER WITH PARTIAL REDISTRIBUTION: A PRELIMINARY STUDY OF LYMAN α IN THE SOLAR CHROMOSPHERE. Milkey, R.W. (Kitt Peak National Observatory); Mihalas, D. Astrophys. J. 185: No. 2, 709-726 (15 Oct 1973).

This paper presents a method for solving resonance-line transfer problems including a detailed treatment of the effects of partial redistribution. Calculations were made for a schematic representation of Lα in the solar chromosphere. We find that the usual assumption of complete redistribution leads to spurious estimates of number densities, the Lyman continuum, and the Lα profile, and thus we support the conclusions of Vernazza and of Vernazza, Avrett, and Loeser. Although we have made too many simplifications in the current computations to be able to compare with the observed Lα profile in detail, the differential behavior of our results for several cases supports the suggestion made in the papers cited above that the scattering in the Lα wing is well described as dominantly coherent. The methods developed here are easily extended to more realistic models and can be applied to many other lines of interest. (auth)

1114 HEIGHT DISTRIBUTION AND DIRECTIONALITY OF 2-12 Å X-RAY FLARE EMISSION IN THE SOLAR ATMOSPHERE. Catalano, C.P.; Van Allen, J.A. (Department of Physics and Astronomy, The University of Iowa, Iowa City). Astrophys. J. 185: No. 1, 335-349 (1 Oct 1973).

The emission of soft X-rays (2-12 Å) in solar flares has been studied in a new way by using simultaneous observations by two spacecraft near the Earth (Explorers 33 and 35) and another at a markedly different heliocentric longitude (Mariner 5) during the 117-day period 1967 July 28-November 21. Detailed intensity versus time observations on 607 separate flares were obtained. The principal findings are: (a) The effective temperature T of the emitting plasma is $(8\pm2)\times10^6$°K for flares of small and moderate intensity. T increases to $\simeq20\times10^6$°K for the most intense flares. (b) The angular distribution of emission is independent of solar zenith angle to an accuracy of a few percent. (c) For flares that are fully visible from one spacecraft but partly occulted by the solar disk as viewed by the other, the dependence of soft X-ray emission I on altitude h above the photosphere is found to be well represented by $dI/dh \propto \exp(-h/h_0)$ with $h_0 = (11 \pm 3) \times 10^3$ km. (auth)

1115 X-RAY FLARE PLASMA TEMPERATURE: A COMMENT ON A PAPER BY DESHPANDE AND TANDON. Phillips, K.J.H. (Laboratory for Solar Physics, NASA-Goddard Space Flight Center, Greenbelt, Maryland); Culhane, J.L. Astrophys. J. 185: No. 1, 351-352 (1 Oct 1973).

A recent analysis by Deshpande and Tandon extracts solar flare temperatures from ion-chamber data. The neglect of line and free-bound continuum emission in the source function and the assumption of constant emission measure as a function of temperature must lead to considerable uncertainty in their results and any conclusions drawn from them. (auth)

1116 FLARE TRIGGERING BY COHERENT OSCILLATIONS. Mullan, D.J. (Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania). Astrophys. J. 185: No. 1, 353-356 (1 Oct 1973).

Energy fluxes in coherent oscillations observed by Tanaka in Hα plages are estimated to be very large, $(0.95\text{-}4.50)\times10^{10}$ ergs cm^{-2} s^{-1} During their lifetime ($\simeq 10^3$ s) these oscillations transmit up to 10^{34} ergs to the chromosphere, sufficient to provide for a large flare even if the efficiency of conversion into electromagnetic and corpuscular energies is only 1 percent. If these oscillations do not in fact provide the energy released in a flare, they are expected to be at least important in triggering a flare, as Tanaka has observed. The coherent oscillations are thought to to be free modes of the Sun (as described by C. L. Wolff), preferentially excited in plages near sun-spots where subphotospheric magnetic fields modify the structure of the convection zone. (auth)

1117 CHANGES IN THE DISTRIBUTION OF DENSITY AND RADIO SCATTERING IN THE SOLAR CORONA IN 1971. Counselman III, C.C. (Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge); Rankin, J.M. Astrophys. J. 185: No. 1, 357-362 (1 Oct 1973).

The mean electron density of the solar corona has been determined from measurements of the dispersion of radiofrequency pulses from

pulsar NP 0532 at times surrounding the occultation of 1971 June. During this occultation the integrated electron density along the pulsar–Earth line did not vary as rapidly with solar elongation as in 1969 and 1970: 17 $r_\odot$ east and west of the Sun the integrated density was 50 percent greater, but $r_\odot$ south of the Sun (closest approach). the integrated density was 50 percent less, than the corresponding values measured in 1969 and 1970. Model-fitting results suggest that in 1971 the corona was much more concentrated toward the equator, and the density decreased more slowly with increasing radius, than in 1969 and 1970. The equatorial density at 10 $r_\odot$ inferred in 1971 was about 8000 electrons cm^{-3}, essentially the same as in 1969 and 1970. However, the coronal multipath scattering delay in 1971 was less than one-tenth that measured in 1969 and 1970, implying that a marked decrease in coronal inhomogeneity has accompanied the decline in other indices of solar activity during this period. (auth)

Galaxies

1118 CORRELATION SEARCH FOR DISPERSED RADIO EMISSION FROM THE GALACTIC CENTRE. Edwards, P. J.; Hurst, R. B.; McQueen, M. P. C. (Otago Univ., Dunedin, N. Z.). Nature (London); 247: No. 5441, 444-446(15 Feb 1974).

The results of a search for fluctuations in the intensity of radio emission from the vicinity of the galactic center are reported. A two-channel cross-correlation technique was employed. The incentive to look for a time-variable radio flux from the region of the galactic center arose primarily from reports of impulsive gravitational radiation, and reports of impulsive radio events. Making use of dispersion phenomena a delayed correlated component to the intensity fluctuations at two neighbouring frequencies was looked for, allowing the detection of dispersed transients well below the rms fluctuation noise level. The 150 m meridian transit telescope of Otago University was used in the search, operated at 120 and 130 MHz as a two-element phase switched interferometer in order to minimise interference and reduce instrumental drift. Full details are given of the technique employed, and the results are discussed. Several possible sources of variability are discussed. (UK)

1119 REACTIONS IN THE FORMATION OF INTERSTELLAR RADICALS AND MOLECULES. Harteck, P.; Reeves, R. R. (Rensselaer Polytechnic Inst., Troy, NY). (1973). vp.

From 11th international symposium on free radicals; Berchtesgaden, Ger. (4 Sep 1973).

The authors try to develop a series of reaction mechanisms which seem to explain the occurrence of the observed interstellar molecules in the dark clouds. Special emphasis is given to the dominant role of H_3^+ which acts as a proton donor for the formation of ion molecules like COH^+, CH^+, NH_4^+, which are very reactive and lead over a series of intermediates to observed species such as: OH, H_2CO, NH_3, CH, and HCN. The formation of these molecules occurs in the gas phase, a fact which does not exclude the formation of molecules on the surface of grains or in ion-clusters. (GE)

1120 THE "ROLLING MOTION" PHENOMENON IN GALACTIC SPIRAL ARMS. Yuan, C.; Wallace, L. (City College of New York, New York City). Astrophys. J. 185: No. 2, 453-475 (15 Oct 1973).

The "rolling motions" in the spiral arms in the outer parts of the Galaxy are interpreted as only apparent motions caused by the combined effect of the bending of the galactic plane and the differential rotation. Theoretical contour maps (latitude versus velocity) are constructed in a number of directions on both sides of the Galaxy for direct comparison with observations. The velocity and density fields used in the calculations are based on a linear analysis of the three-dimensional gas motions in response to the spiral density-wave potential studied by Lin, Shu, and Yuan; Shu; and Vandervoort. It is found that the combined effect of the bending of the plane and differential rotation is sufficient to cause an apparent rolling motion in a spiral arm. The same mechanism can be applied to the explanation of the "rolling motions" for the spiral arms interior to the position of the Sun, if the arms are displaced slightly from the central plane. However, the issue is much complicated by distance ambiguity, crowding effect in velocity, etc. Only fair agreement is attained. It has also been shown that the galactic magnetic fields with the strength and topology consistent with the observations are unlikely to generate any actual rolling motions in the spiral arms. (auth)

1121 THE FORMATION AND DEPLETION OF MOLECULES IN DENSE INTERSTELLAR CLOUDS. Herbst, E.; Klemperer, W. (Department of Chemistry, Harvard University). Astrophys. J. 185: No. 2, 505-533 (15 Oct 1973).

The rates of a number of homogeneous gas phase chemical reactions likely to occur in dense interstellar clouds composed primarily of molecular hydrogen are considered. Over 100 reactions are included; of these, more than half have known rate constants. These reactions are sufficient to produce and destroy polyatomic species such as H_2O, HCN, NH_3, and H_2CO. Steady-state abundances of about 35 species are calculated for clouds of density $10^4 \leq n_{H2} \leq 10^6$ cm^{-3}. Calculations are performed for cosmic-ray—induced ionization rates $\zeta_{H2} = 10^{-17}$ and 10^{-16} s^{-1}. Typical times for reaching steady-state ($n_{H2} = 10^5$ cm^{-3}, $\zeta_{H2} = 10^{-17}$ s^{-1}) vary for different species; e.g., $H_2^+ \simeq 0.05$ day, $H_3^+ \simeq 0.3$ year, $H_2O \simeq 3 \times 10^3$ years. Comparisons of calculated and observed column densities are presented for a number of regions. (auth)

1122 THE OPTICALLY VARIABLE GALAXY X COMAE. Bond, H.E. (Louisiana State University Observatory); Sargent, W.L.W. Astrophys. J. Lett. 185: No. 3, L109-L111 (1 Nov 1973).

The optically variable object X Com is shown to be an N-type galaxy with a Seyfert-like emission-line spectrum and a redshift $z = 0.092$. X Com experiences occasional outbursts of 1–3 mag with time scales of a few months, separated by long quiescent intervals. During a particularly violent outburst in 1911, observed by Max Wolf, X Com became as luminous as some QSOs and probably had a stellar appearance; thus we suggest that a quasar briefly appeared at the center of this galaxy. (auth)

1123 A RADIALLY STREAMING PROTON MODEL FOR THE BROAD COMPONENT OF HYDROGEN EMISSION IN SEYFERT GALAXIES. Ptak, R.; Stoner, R.E. (Department of Physics, Bowling Green State University, Bowling Green, Ohio). Astrophys. J. 185: No. 1, 121-135 (1 Oct 1973).

We present details of the calculation of the profile of the Hα emission line in Seyfert galaxies. The calculation is performed using a model in which fast protons move radially outward through a partially ionized gas. The emission from these streaming protons, which arises from atomic collision processes, produces the broad component of the hydrogen lines. Continuous absorption from a surrounding medium produces the asymmetry in the profiles. High-resolution spectrograms are availabe for three Seyfert galaxies—NGC 3516, NGC 4151, and NGC 5548, and the wings of the calculated Hα profiles are in excellent agreement with the observations in these three cases. In the simplest version of the model, the protons are all emitted with the same energy from a small source, and then stream isotropically outward through a uniform, partially ionized hydrogen gas. We also discuss two modifications of this version. In the one we consider some deviation from spherical symmetry, and in the other we investigate the effect of having the emission occur over some distribution of radial distances. For the three Seyfert galaxies mentioned above, the proton distribution appears to be close to spherical symmetry. A wide range of possible distributions in the radial distance at which the protons produce most of their emission is compatible with the data. Subject headings: line profiles—Seyfert galaxies (auth)

Cosmology

Refer also to abstracts 1366, 1426, 1808, and 1815.

1124 LIMIT ON VARIATION OF G FROM CLUSTERS OF GALAXIES. Dearborn, D. S.; Schramm, D. N. (Univ. of Texas, Austin). Nature (London); 247: No. 5441, 441-443(15 Feb 1974).

It is stated that if G decreases by a sufficient amount a cluster of particles will expand. In some cases the particles may have sufficient velocity to escape from the cluster as the gravitational binding decreases. Since it is known that clusters of galaxies and globular clusters currently exist with finite dimensions, limits can be set on the magnitude of the variation of G. In order to set a limit on the rate of change of the gravitational constant (G/G), the dynamical effects on an isolated cluster of galaxies caused by non-zero values of G/G were studied numerically. For a range of initial conditions the maximum rate of change in G was determined which would still allow the existence of clusters of galaxies at the current epoch. A similar study was made for globular clusters and the results were found to be comparable. (auth)

1125 ASTROPHYSICAL FUEL–COOLANT INTERACTIONS. Ashby, D. E. T. F.; Buchanan, D. J.; Peckover, R. S. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nature (London); 247: No. 5439, 272-273(1 Feb 1974).

It is stated that if a hot liquid comes into contact with a cold vaporisable liquid a violent explosion may occur, such interactions often being termed "fuel–coolant" interactions (FCIs). In this communication FCI theory is discussed and applied to the problem of matter and antimatter interacting on an astronomical scale. It has been suggested (Alfven, Rev. Mod. Phys. 37: 652 (1965)) that regions of matter and antimatter could be separated by a thin Leidenfrost layer of radiation sustained by gradual annihilation. The following can then be postulated: a perturbation locally decreases the thickness of the radiation layer, increasing

the annihilation rate, and leading to the formation of a radiation bubble. The bubble expands initially and, provided the radiation escapes, it then collapses. Departure from mirror symmetry can result in the formation of a jet of matter, if the bubble is in the matter region, and if this jet penetrates the antimatter region further annihilation will occur and another bubble will be formed. Significant differences in density, viscosity or magnetic-field strength constitute departures from symmetry, and the possibility exists of explosive mixing of matter with antimatter, analogous to fuel–coolant interactions. The stability of the Leidenfrost layer postulated by Alfven depends critically on the Schwarzschild number and the degree of symmetry at the matter/antimatter interface. For FCI theory see Buchanan and Dullforce, Nature 245: 32 (1973), and for Leidenfrost layer see Omnes. Astr. Astrophys. 15: 275 (1971) and Phys. Lett. 3C: 1 (1972). (UK)

1126 INTRODUCTION A LA COSMOLOGIE. (Introduction to Cosmology). Heidmann, J. Collection SUP-Le Physicien, No. 7. Paris; Presses Universitaires de France (1973). 240p. (In French). $0.95.

The fundamental elements of cosmology are outlined, the subject being the study of the Universe on a large scale. Up to several billions of light years, the classical Euclidean framework suffices to attack the various important questions of cosmology: scale of distances, distribution of galaxies in space, expansion of the Universe, age of the Universe, etc. Farther in space, the escape speeds of the stars approach so closely to the speed of light that important relativistic effects enter into play; furthermore, the time of passage of the waves increases and observation makes it possible to return to the past history of the Universe. Thus penetration is made into the region of cosmology proper, the most simple aspects of which are studied. The metagalaxy up to a gigaparsec, spaces at constant curvature, models of the Universe, and the metagalaxy in the relativistic zone are considered. (IAA)

1127 ATTEMPT TO MEASURE THE FAR INFRARED SPECTRUM OF THE COSMIC BACKGROUND RADIATION. Gush, H. P. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 6, 554-561(15 Mar 1974).

A liquid helium cooled two-beam far infrared interferometer has been successfully flown in a Black Brant III B rocket. The detector was a germanium bolometer cooled to a temperature of 0.37 K by a liquid ^{3}He refrigerator. The sensitive range was between approximately 5 and 50 cm^{-1}. Satisfactory cosmic spectra were not obtained because of contamination by radiation from the Earth. (auth)

1128 ASTROPHYSICS. Rose, W. K. New York; Rinehart and Winston, Inc. (1973). 296p. $14.00.

The subject of cosmology is briefly introduced, and the major constituents of space are described, with major attention to the physical properties of the interstellar medium. The basic properties of stars are considered, with discussion of the equations and physical processes that are most important in understanding stellar interiors. The history of stars from their origin to final states is traced. Attention is given to supernovae, pulsars, and neutron stars. Normal galaxies, i.e., those whose emitted radiation is primarily thermal, are discussed, followed by a study of Seyfert galaxies, radio galaxies, and quasi-stellar objects whose emitted radiation is primarily nonthermal. Recent efforts to obtain evidence about cosmology (magnitude–redshift measurements of galaxies, numbers counts of radio sources, and background radiation measurements) are discussed, and an introduction to cosmological theory is given. Since the discovery of the microwave background radiation is the most important known clue concerning the origin and evolution of the Universe, major attention is given to a discussion of its consequences. (IAA)

1129 ASTROPHYSICAL ENIGMA OF ENERGY SOURCE. Popovici, C. Stiinta Solului; No. 11, 18-20(Nov 1973).

The first concrete answer regarding the source of solar and stellar energy was provided by H. Bethe in 1939, when he suggested the carbon–nitrogen cycle in which the protons are converted by thermonuclear reactions into alpha particles. Subsequently, it was pointed out that for the Sun, the proton–proton reaction produces the greatest part of its energy of 3.8×10^{33} ergs. The stars shine as a result of thermonuclear fusion (hydrogen turns into helium, helium into carbon, and so forth). Moreover, the radiogalaxies and quasars have outstanding outputs of energy (Quasar 3 C273 has a luminosity of 6.2×10^{46} ergs/sec.). Outstanding approaches to studying the source of this energy involve the matter–antimatter annihilation process and potential gravitation energy. The former approach suggests that the quasars contain cosmological remains in small areas with matter and antimatter whose current annihilation generates considerable energy. The latter approach holds that energy results from a gravitational collapse, with a rapid explosion leading to a black hole. The possibility of extracting energy from black holes is discussed. A suggestion involves the fall of adjacent matter into the black holes with an accompanying considerable release of energy, x rays, and gravitational waves which may result in an amount of energy almost half the rest mass of the body absorbed. The author quotes V. Ambartumian who believes that observational evidence involves explosions and ejection of matter and not concentration of mass. (Referativnyi Zh.)

1130 ANTIWORLD, A PHYSICAL CERTAINTY. Vlaicu, R. Stiinta Solului; No. 11, 22-23(Nov 1973).

A review is given of cosmological theories which have gained ground in modern astronomical circles. According to George Gamow's big bang theory, the atoms of the current cosmic factors developed about 10 billion years ago as a result of the formidable explosion of a huge aggregate of very dense matter. This theory was confirmed in 1965 when astrophysicists Arno A. Penzias and Robert W. Wilson discovered the isotropic thermal radiation (3°K), which has a homogeneous distribution. Gamow's theory does not explain the energy of quasars. An answer to this might be found in the cosmological theory based on matter and antimatter. The proponents of this theory accept Gamow's theory as corresponding to the protouniverse, after which the "hadronic" era and a phase transition followed. Emphasis is placed on the contributions of Swedish researchers Hannes Alfven and Oscar Klein, the French group led by Roland Omnes, and others. The importance of the experiments on Explorer 11, Apollo 15, OSO 3, and SAS 11 for detecting the gamma radiation with energies of more than 30 MeV which is presumed to be of extragalactic origin is also pointed out. (Referativnyi Zh.)

1131 METHOD FOR DETECTING A COSMOLOGICAL DENSITY OF CONDENSED OBJECTS. Press, W.H.; Gunn, J.E. (California Institute of Technology, Pasadena). Astrophys. J. 185: No. 2, 397-412 (15 Oct 1973).

This paper discusses a technique for detecting a cosmologically significant density of condensed objects (subluminous stars, dead clusters or galaxies, black holes): If the Universe is filled with roughly a critical density of such objects, the probability is high that a distant point source will be gravitationally imaged into two roughly equal images. This conclusion is independent of the mass M of the objects, which only sets the scale of the image doubling, $\simeq 2.6 \times 10^{-6} (M/M_\odot)^{1/2}$ arc seconds. Detailed statistical predictions for the relative intensity and separation of images are derived. Using optically identified QSRSs as the distant point sources, and present VLBI techniques, the mass range down to 10^4 $M_\odot$ can be investigated directly. Indirect arguments may rule out smaller masses. (auth)

1132 STATISTICAL ANALYSIS OF CATALOGS OF EXTRAGALACTIC OBJECTS. I. THEORY. Peebles, P.J.E. (Joseph Henry Laboratories, Physics Department, Princeton University). Astrophys. J. 185: No. 2, 413-440 (15 Oct 1973).

This paper is the first in a series on a systematic analysis of a number of catalogs of extragalactic objects. The method is based on the "analysis of power spectra," as elucidated by Tukey. As workers in other fields have abundantly shown, this method, which combines the virtues of the power spectrum with the utility of its transform, the covariance function, can be a powerful and discriminating statistical test. Presented here are a number of theoretical results necessary for the analysis of data distributed on a sphere. Some results are close analogs of corresponding formulae for a distribution in flat space. Others are directed to the problem of relating the observed two-dimensional distribution to the three-dimensional spatial distribution. (auth)

1133 ON A POSSIBLE REPULSIVE INTERACTION IN UNIVERSAL GRAVITATION. Chiang, C.C. (Center for Particle Theory, The University of Texas at Austin); Dykla, J.J.; Hwang, A.E. Astrophys. J. 185: No. 1, 87-90 (1 Oct 1973).

A recent solution of the Einstein field equations suggests the possibility of a universal repulsive component in gravity. We examine the consequences of such a possibility by considering macroscopic systems and conclude that such a repulsive component in gravity is compatible with the present observational data. Subject headings: gravitation—relativity (auth)

1134 THE PRODUCTION OF VORTICITY IN AN EXPANDING, SELF-GRAVITATING FLUID. Olson, D.W. (Department of Physics, University if California, Berkeley); Sachs, R.K. Astrophys. J. 185: No. 1, 91-104 (1 Oct 1973).

A self-gravitating Newtonian perfect fluid is analyzed statistically. For homogeneous, isotropic turbulence the equations imply an expanding (or contracting) "background" model governed by the Friedmann equation. If density fluctuations are negligible and random velocity moments obey a limited joint-normal statistical assumption, then the equation for the mean-square vorticity $\langle \omega^2 \rangle$ can be solved exactly, incorporating nonlinear hydrodynamic effects. For an expanding background, two qualitatively different types of solution can occur. If the background expansion eventually dominates, $\langle \omega^2 \rangle$ eventually has the R^{-4} behavior

expected from perturbation theory. But if the fragmentation of eddies dominates, the solutions for $\langle\omega^2\rangle$ blow up in a finite time. For a contracting background the solutions for $\langle\omega^2\rangle$ always blow up in a finite time. A simple physical interpretation is suggested for the formal results. Subject headings: cosmology—hydrodynamics—turbulence (auth)

1135 INDEPENDENT INVESTIGATIONS CONCERNING BULK VISCOSITY IN RELATIVISTIC HOMOGENEOUS ISOTROPIC COSMOLOGIES. Nightingale, J.D. (Physics Department, State University of New York, New Paltz). Astrophys. J. 185: No. 1, 105-114 (1 Oct 1973).

Formulae are found (in those cosmologies that involve an isotropic and homogeneous expansion) for the perturbed Weltradius, energy density, and age, when bulk viscosity is considered nonnegligible. The coefficient of bulk viscosity is found via the relativistic Boltzmann equation, following Anderson's work on the Grad method of moments. The specific form of the coefficient is given, and it is found that it does not depend upon the Hubble constant. It is also estimated that this particular coefficient (different from Weinberg's) could not be responsible for the entropy associated with the background radiation. Some of the results overlap and verify (by different methods) some of the work done by Weinberg, Treciokas and Ellis, and Neugebauer and Strobel. Subject heading: cosmology (auth)

1136 ON A CRITERION FOR THE OCCURRENCE OF A DEDEKIND-LIKE POINT OF BIFURCATION ALONG A SEQUENCE OF AXISYMMETRIC SYSTEMS. I. RELATIVISTIC THEORY OF UNIFORMLY ROTATING CONFIGURATIONS. Chandrasekhar, S.; Friedman, J.L. (University of Chicago). Astrophys. J. 185: No. 1, 1-18 (1 Oct 1973).

Stationary nonaxisymmetric systems in general relativity are considered. It is shown that the theory of such systems can be developed along lines which closely parallel the theory of nonstationary axisymmetric systems. Equations are derived which govern small nonaxisymmetric departures from equilibrium of axisymmetric configurations of perfect fluid in uniform rotation. In terms of these equations, the condition that a uniformly rotating configuration will allow a quasi-stationary nonaxisymmetric deformation with a ϕ-dependence of the form $e^{im\phi}$ (where m is an integer greater than or equal to one) is obtained. A variational principle expressing this condition is also derived. Subject headings: relativity—rotation (auth)

1137 ON A CRITERION FOR THE OCCURRENCE OF A DEDEKIND-LIKE POINT OF BIFURCATION ALONG A SEQUENCE OF AXISYMMETRIC SYSTEMS. II. NEWTONIAN THEORY FOR DIFFERENTIALLY ROTATING CONFIGURATIONS. Chandrasekhar, S.; Lebovitz, N.R. (University of Chicago). Astrophys. J. 185: No. 1, 19-30 (1 Oct 1973).

The equations in the Newtonian theory, which govern quasi-stationary nonaxisymmetric deformations of axisymmetric configurations in nonuniform rotation, are derived; and the condition for the existence of such deformations with a ϕ-dependence of the form $e^{im\phi}$ (where m is an integer greater than or equal to 1) is expressed in terms of a variational principle. The condition for the case m=2 applies for the occurrence of a Dedekind-like point of bifurcation. In an appendix the variational principle governing the axisymmetric modes of oscillation of differentially rotating systems is reformulated in a manner that avoids the solution of a second-order partial differential equation. Subject heading: rotation. (auth)

1138 RELATIVISTIC GRAVITY IN THE SOLAR SYSTEM. III. EXPERIMENTAL DISPROOF OF A CLASS OF LINEAR THEORIES OF GRAVITATION. Will, C.M. (University of Chicago). Astrophys. J. 185: No. 1, 31-42 (1 Oct 1973).

We analyze a class of "linear" metric theories of gravitation, and show using the Parametrized Post-Newtonian formalism that they are unviable: they predict that our Galaxy should induce anisotropies in the Newtonian gravitational constant G which lead to solid-Earth tides more than 20 times larger than gravimeter measurements permit. Among the theories ruled out are those devised by Deser and Laurent and by Bollini, Giambiagi, and Tiomno. Subject headings: gravitation—relativity (auth)

Planetary Phenomena

1139 LOWER IONOSPHERE OF VENUS. Dubach, J.; Whitten, R. C.; Sims, J. S. (Stanford Univ., CA). Planet. Space Sci.; 22: No. 4, 525-536(Apr 1974).

Galactic cosmic-ray bombardment provides a permanent background ionosphere in planetary atmospheres. A transport technique is used to compute the cosmic-ray ionization rate profile in a model of the Venusian atmosphere at altitudes between 55 and 100 km. These ionization rates are then applied to a model of ion chemistry to predict equilibrium electron and ion density profiles. Ionization rates for typical solar-flare proton events are available from earlier calculations and have been included. (auth)

1140 FREE RADICALS IN THE ATMOSPHERES OF MARS AND VENUS. Barth, C. A. (Univ. of Colorado, Boulder). (1973). vp.

From 11th international symposium on free radicals; Berchtesgaden, Ger. (4 Sep 1973).

As a result of the exploration of Mars and Venus by planetary spacecraft, it is now known that the atmospheres of both of these planets are predominantly carbon dioxide. Direct observational information on the presence of free radicals in the Mars atmosphere has been obtained by the Mariner ultraviolet spectrometer experiments. These observations may be interpreted in the context of theoretical studies of the photochemistry of the Mars atmosphere. In that the composition of the atmospheres of Mars and Venus are similar, the theoretical conclusions from Mars photochemistry may be applied to Venus. (auth)

1141 ISOTOPIC EVIDENCE FOR A TERMINAL LUNAR CATACLYSM. Tera, F.; Papanastassiou, D. A.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 22: No. 1, 1-21(Apr 1974).

Most highland total rock samples define a single U–Pb isochron which corresponds to a metamorphism age of ~3.9 AE. This age is also obtained for internal U–Pb isochrons for some of these samples. The data on 18 rock samples range from concordant samples with $^{238}U/^{206}Pb \sim 1.2$ to discordant ones with $^{238}U/^{206}Pb \sim 0.02$. This feature coupled with a correlated pattern of $^{238}U/^{204}Pb$ ratios, indicates that Pb was extensively mobilized at ~3.9 AE. The observed Pb–U fractionation is essentially due to Pb volatilization during the metamorphic events. Volatile Pb transport is not accompanied by similar effects in Rb and must therefore be attributed to a specific process. Rb–Sr internal isochrons for the same rocks determine distinct metamorphic events in the interval 3.85 to 4.00 AE. It is concluded that highland samples from widely separated areas bear the imprint of an event or series of events in a narrow time interval which can be identified with a cataclysmic impacting rate of the Moon at ~3.9 AE, although differentiation by internal magma generation cannot be excluded. This cataclysm is associated with the Imbrium impact and very possibly the formation of Crisium and Orientale and possibly several other major basins in a narrow time interval ($\sim 2 \times 10^8$ yr or less). The U–Pb data indicate formation of the lunar crust at ~4.4 AE, which is distinctly younger than 4.6 AE, the time generally associated with planetary formation. If the lunar crust started being formed at ~4.6 AE, then this process must have continued until times significantly younger than 4.4 AE. Rb–Sr data also indicate formation of the lunar crust around 4.5 AE with only minor additions of high Rb/Sr materials to the crust at times younger than 4.3 AE. Using the U–Pb systematics, K/U and the average U concentration of the Moon as obtained from heat-flow measurements, the lunar concentrations are estimated as: primordial Pb = 35 ppB; Rb = 0.5 ppM with Rb/Sr = 0.006. (auth)

1142 ISOTOPE COMPOSITION OF HELIUM IN ULTRABASIC XENOLITHS FROM VOLCANIC ROCKS OF KAMCHATKA. Tolstikhin, I. N. (Inst. of Precambrian Geology and Geochronology, Leningrad); Mamyrin, B. A.; Khabarin, L. B.; Erlikh, E. N. Earth Planet. Sci. Lett.; 22: No. 1, 75-84(Apr 1974).

The purpose of this work is to refine the knowledge about the nature of helium with a high abundance of the rare isotope ^3He ($^3He/^4He = 10^{-5}$) discovered in terrestrial volcanic gases in 1968. The results of isotope analyses of helium released by step-wise heating of ultrabasic xenoliths and some volcanic rocks are discussed. On the basis of these results, possible sources of ^3He in the Earth due to fission and nuclear reactions are considered critically. The most probable source of the high abundance of ^3He is shown to be due to the capture and trapping of primordial He by the Earth during its formation (primordial helium $^3He/^4He = 3 \times 10^{-4}$), a small but significant fraction of which has been retained to the present time. (auth)

1143 $^{18}O/^{16}O$ RATIOS IN LUNAR FINES AND ROCKS. Javoy, M.; Fourcade, S. (Univ., Paris). Earth Planet. Sci. Lett.; 21: No. 4, 377-382(Mar 1974).

$^{18}O/^{16}O$ ratios were measured for Luna 20 and Apollo 15 fines and Apollo 15 rocks. Isotopic composition and fractionation between minerals are compared with previous results. Partial fluorination experiments on Luna 20 soil and Apollo 15021 extreme fines show large ^{18}O enrichments in grain surfaces. These results are discussed. (auth)

1144 LUNAR RED SPOTS: POSSIBLE PRE-MARE MATERIALS. Malin, M. C. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 21: No. 4, 331-341(Mar 1974).

Some anomalous red features observed on the Moon by Whitaker are examined in detail. Crater counts and regional stratigraphy suggest that ages for these features are comparable to that of lunar highland material. Initial gamma-ray spectrometry indicates higher than average native radioactivity is associated with certain

red areas. A possible explanation for these observations is that the red objects are the surface manifestation of highly radioactive pre-mare basalts (Apollo 14/KREEP/norite material). Conclusive proof of the nature of these objects will depend on the study of returned samples, making them ideal candidates for future space missions, especially for unmanned vehicles such as the Soviet Union's Luna 20. (auth)

1145 THE SPLIT TAIL OF COMET SEKI–LINES. Jambor, B.J. (Martin Marietta Aerospace, Denver, Colorado). Astrophys. J. 185: No. 2, 727-734 (15 Oct 1973).

Comet Seki–Lines was analyzed using a method previously applied to comet Arend–Roland. The split tail is a dust tail which resulted from the combination of a sudden increase of grain production and fast melting near perihelion. A suggestion is made for the origin of split tails in other comets. (auth)

1146 HIGH-ANGULAR-RESOLUTION OBSERVATIONS OF SATURN AT 21.1-CENTIMETER WAVELENGTH. Berge, G.L.; Muhleman, D.O. (Owens Valley Radio Observatory and Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California). Astrophys. J. 185: No. 1, 373-381 (1 Oct 1973).

Saturn was observed with an interferometer at a wavelength of 21.1 cm in an effort to determine whether any of the emission at this wavelength originates from outside the area of the visible disk. The result, in terms of upper limits, is that no more than 6 percent can come from the visible rings nor more than 5 percent from a radiation belt, assuming brightness distribution models that we describe. The latter limit implies that the volume emissivity of a hypothetical Saturn radiation belt has an upper limit of only about 1 percent of that for Jupiter in corresponding regions. The measured disk temperature is 232° ± 18°K. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

1147 (AD-769216) PHYSICS AND CHEMISTRY OF TWO NRL CODES FOR THE DISTURBED E AND F REGIONS. Ali, A. W. (Naval Research Lab., Washington, D. C. (USA)). 4 Oct 1973. 32p. (NRL-7578). NTIS $3.00.

NRL has developed two computer codes to describe the ionization and deionization phenomena of the upper atmosphere. The detailed physics and the chemistry of these codes, called the Simple and the Master Codes, describe the disturbed E and F regions of the ionosphere. The Simple Code carries less species (atoms, molecules, and ions) than the Master Code, but both codes are used to calculate three temperatures—electron, N_2 vibrational, and heavy particle. Both codes agree with each other in electron density calculations to better than 20%. (auth)

1148 INTERPRETATION OF SOME OBSERVATIONS OF RADIO WAVES SCATTERED FROM THE LOWER IONOSPHERE. Vincent, R. A. (Univ. of Adelaide). Aust. J. Phys.; 26: No. 6, 815-827(Dec 1973).

Possible shapes and spatial scales of ionospheric irregularities in the lower ionosphere have been determined from analyses of two sets of radio wave back-scattering observations: measurements of the spatial scale of the ground pattern of the wave field back-scattered from altitudes near 95 km and measurements of the amount and angular distribution of power back-scattered from solitary horizontally-moving irregularities at altitudes near 75 km. At 95 km the irregularities are anisotropic, with larger horizontal than vertical dimensions. For an assumed Gaussian distribution of ionization, the inferred axial ratio (horizontal to vertical) is about three. It is tentatively concluded that the irregularities at 75 km are sharply bounded and are some kilometres in horizontal extent. (auth)

1149 RADIO PROPAGATION MEASUREMENTS OF AURORAL IONIZATION USING ROCKET-BORNE TRANSMITTERS. Forsyth, P. A.; Palmer, F. H. (Univ. of Western Ontario, London). Can. J. Phys.; 52: No. 2, 140-145(15 Jan 1974).

Three rockets carrying radio propagation experiments were launched respectively into the prebreakup, breakup, and post-breakup phases of auroral displays during early 1968. The radio measurements, which provide information concerning the three-dimensional spatial gradients in ionization, show quite different characteristics for the three occasions. In the first two it seems that the configuration of ionization was essentially similar to that of the visible aurora. In the third, during a widespread homogeneous auroral glow, the ionization showed weak small-scale irregularities, possibly generated locally by plasma instabilities. Data from a ground-based photometer and from particle precipitation experiments aboard two of the rockets are also compared with the radio evidence. (auth)

1150 ELECTRIC CLOUD AND WEATHER MODIFICATION WITH INTENSE RELATIVISTIC ELECTRON BEAMS. Winterberg, F. (Univ. of Nevada, Reno). Nature (London); 247: No. 5439, 271(1 Feb 1974).

A method is proposed for weather modification based on the projection of a rapid sequence of intense relativistic electron beams into the atmosphere. A beam of electrons will normally disperse rapidly in the radial direction due to multiple scattering, but this is not the case for an intense beam of relativistic electrons which is confined by its own magnetic field. Beams of up to 10^6 A and with electron energies of many million electron volts and lasting up to 100 ns have been produced by the combination of a Marx surge generator with a Blumlein transmission line, connected to a field emission diode, and the total beam energies so far achieved have reached megajoule values. If such a beam is projected into the atmosphere it will not disperse radially, but will produce a channel of hot air, with a maximum channel length equal to the radiation length in air. If then a second beam is projected into this channel after an interval equal to the time for the air to expand in the heated channel, this second beam will in part propagate through air of reduced density, and because of the reduced attenuation it will propagate further than the first beam. A third beam will propagate even further, and so on. The required rapid sequence of beams can be obtained by a parallel arrangement of Marx generators discharged in a programmed sequence by triggered spark gap switches over the same Blumlein line and discharge diode. The method appears to allow the following: (a) it permits the disposal of a large negative charge into a chosen volume of the atmosphere or of a cloud, (b) the intense relativistic electrons release within the atmosphere a large x-ray flash producing many pairs of positive and negative ions, (c) the beams create within the atmosphere channels of high electrical conductivity. The implications of these effects to cloud and weather modification are manifold. (UK)

1151 AVERAGE NIGHT-TIME ELECTRON DENSITY PROFILES BETWEEN 87 AND 115 KM DERIVED FROM ABSORPTION MEASUREMENTS AT 10 FIXED FREQUENCIES FROM 250 TO 1000 kHz AT TSUMEB (19°S). Elling, W. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). J. Atmos. Terrest. Phys.; 36: No. 4, 619-633(Apr 1974).

Results of absorption measurements carried out in 1964 at Tsumeb, S. W. A., at 10 fixed frequencies between 250 and 1000 kHz are presented and interpreted by theory. The calculations yielded the nighttime E-region (87 to 115 km) average electron-density profiles of the background ionization (averages over 14 nights), in which various E_2 layers were embedded. The electron density (N) decreased continuously with time (t) after sunset in the entire height range. The corresponding recombination coefficients α, defined by the equation $dN/dt = -\alpha N^2$, decreased from 9×10^{-6} cm^3/sec at 87.5 km to 6×10^{-9} cm^3/sec at 115 km. At heights ranging from 87.5 to 97 km α was proportional to atmospheric pressure. Different recombination coefficients were obtained for the two periods from 1800 to 2400 hr and from 0000 to 0600 hr. All these results suggest that different physical processes occur in the nighttime E region depending not only on height but also on time. (auth)

1152 NEW RESULTS ON ELECTRON TRANSPORT IN THE ATMOSPHERE. Berger, M. J.; Seltzer, S. M.; Maeda, K. (National Bureau of Standards, Washington, DC). J. Atmos. Terrest. Phys.; 36: No. 4, 591-617(Apr 1974).

The penetration, diffusion, and slowing down of electrons in a semi-infinite air medium have been studied by the Monte Carlo method. The results are applicable in the atmosphere at altitudes up to ~300 km. Most of the results pertain to monoenergetic electron beams, with energies between 2 keV and 2 MeV, injected into the atmosphere at a height of 300 km, either vertically downwards or with a pitch-angle distribution isotropic over the downward hemisphere. Some results were also obtained for various initial pitch angles between 0° and 90°. Information has been generated concerning the following topics: (a) the backscattering of electrons from the atmosphere, expressed in terms of backscattering coefficients, angular distributions, and energy spectra; (b) the altitude dependence of energy deposition by electrons and by secondary bremsstrahlung, for incident electron beams that are monoenergetic or have exponential spectra with e-folding energies between 5 and 200 keV; (c) the evolution of electron flux spectra as function of the atmospheric depth, for incident beam energies between 2 and 20 keV. (auth)

1153 ESTIMATION OF THE ELECTRIC POTENTIAL FIELD GENERATED BY THE DIURNAL ATMOSPHERIC TIDE WITH THE FIRST NEGATIVE MODE EXCITED IN THE LOWER IONOSPHERE. Murata, H. (Gifu Univ., Japan). Planet. Space Sci.; 22: No. 4, 569-582(Apr 1974).

The electric potential field in the ionosphere, which is generated by the atmospheric tide with the diurnal first negative mode excited in the lower ionosphere, is estimated. An equivalent mode is used instead of the exact mode in the following approximations: (i) the horizontal structure of the energy input is composed of the first two terms of the series expansion of the Hough function with the associated Legendre functions, and (ii) the Coriolis force is assumed to be constant in the equation of motion and the value appropriate to colatitude 45 being used. It is found that the equivalent mode gives a good approximation of the exact mode at mid-latitudes in the neutral atmosphere. The result shows that the oscillation with its temperature variation of about 40 K in the excitation region generates the horizontal electric potential field of 10^{-3} V/m in magnitude. The horizontal pattern of the field distribution is similar to that estimated by many authors. The maximum vertical electric current is about 3×10^{-9} A/m^2 in the dynamo layer. It is found that the "virtual current", introduced by Volland (Cosmic Electrodynamics; 1: 428 (1970)) as a vertical current in and above the dynamo layer, in order to obtain a better agreement between theory and observations of the location of the diurnal symmetric Sq current vortex, is actually to be expected. The vertical current is very small, but this small steady current is necessary for the electric potential field of the dynamo layer to be mapped into the magnetosphere along the lines of the geomagnetic field. (auth)

1154 LOW FREQUENCY IMPEDANCE PROBE IN THE IONOSPHERE. Aso, T. (Kyoto Univ.). Planet. Space Sci.; 22: No. 4, 583-594(Apr 1974).

A low frequency impedance probe designed to detect the ion–electron hybrid resonance in the ionospheric plasma is studied. Firstly, the effect of finite resistance of an ion sheath surrounding a probe is analyzed for the case of a cylindrical probe and quantitative insight into this is given. Secondly, the dissipations due to warm plasma effects which appear in the actual experiment flown aboard a space vehicle are discussed. These depend upon the dimensions of the probe system and the velocity of the system relative to the mean thermal velocity of charged particles. Analyses are then carried out for a simple planar grid model using electrostatic and hydrodynamic approximations. (auth)

1155 TRANSEQUATORIAL V. H. F. TRANSMISSIONS AND SOLAR-RELATED PHENOMENA. Heeran, M. P.; Carman, E. H. (Univ. of Botswana, S. Afr.). Aust. J. Phys.; 26: No. 6, 797-804 (Dec 1973).

Radio and ionospheric data are analyzed to determine the influences of solar–geophysical phenomena on transequatorial v. h. f. transmissions along a European–Southern African circuit. Results over six years show a close dependence on sunspot number. The observed correlation with sudden ionospheric disturbances indicates periodic solar-dependent defocusing of transequatorial signals by the ionosphere, while the combined effects of neutral winds and the position of the magnetic equator appear to control the seasonal behavior of the transmissions. (auth)

1156 DEDUCTIONS OF DAYTIME ELECTRON DENSITY PROFILES FROM VLF MEASUREMENTS OVER A MIDDLE LATITUDE PATH DURING QUIET CONDITIONS. Bjoentegaard, G. (Norske Institutt for Fysikk, Oslo). J. Atmos. Terrest. Phys.; 36: No. 4, 693-698(Apr 1974).

The first order mode phase velocity (v) is assumed only to be a function of zenith angle (χ) along the 8200 km vlf path from Hawaii to Cambridge, Mass. (U.S.A.). On this assumption $c/v(\cos\chi)$ is constructed from vlf phase measurements on 10.2 kHz averaged over 10 days in May 1969. By calculating the phase velocity for a number of electron-density profiles, an example is given of a set of electron profiles which could describe the development of electron-density profiles of the C and D regions during the day. The minimum in vlf phase frequently observed immediately after sunrise is explained by filling up the minimum in electron density between the ionospheric C and D layer. (auth)

1157 PLASMA PILE-UP IN THE F-REGION. Rishbeth, H.; Hanson, W. B. (Univ. of Texas, Dallas). J. Atmos. Terrest. Phys.; 36: No. 4, 703-706(Apr 1974).

At ionospheric heights the geomagnetic field is virtually incompressible. In consequence, an electromagnetic drift can only compress the F-region plasma by moving it in a direction in which the field becomes stronger. This paper examines the rate of compression at mid-latitudes for three different assumptions about the ion motion. (auth)

1158 POSSIBLE CAUSE OF DAYSIDE RELATIVISTIC ELECTRON PRECIPITATION EVENTS. Thorne, R. M. (Forsuarets Forskningsenstitutt, Kjeller, Norway). J. Atmos. Terrest. Phys.; 36: No. 4, 635-645(Apr 1974).

Energetic radiation belt electrons can resonate with plasma waves resulting in pitch-angle scattering and a concomitant precipitation loss to the upper atmosphere. Enhanced levels of electromagnetic ulf and elf turbulence have recently been reported in association with detached regions of high density plasma in the outer magnetosphere. This is consistent with unstable cyclotron resonant generation which occurs most favorably at plasma densities higher than normally existant outside the plasmapause. The observed amplitude of ulf turbulence is sufficient to induce parasitic pitch-angle scattering of relativistic electrons at the strong diffusion limit. Such electrons should thus precipitate with an isotropic pitch-angle distribution and for $5 \lesssim L \lesssim 7$ could produce sufficient D-region ionization below 70 km to account for the anomalous dayside attenuation of forward scatter signals reported by Bailey (Rev. Geophys.; 6: 289 (1968)). In association with such REP events one should also observe intense precipitation of less energetic electrons and protons. Similar precipitation events should occur at night preceding the dayside REP by up to 1 hr. (auth)

1159 STUDY OF THE LOWER IONOSPHERE BY THE METHOD OF PARTIAL REFLECTIONS. Bezruchenko, L. I.; Belen'kii, M. I.; Tikhomirov, S. P. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.). 13: No. 3, 445-447 (1973).

Translated from Geomagn. Aeron.; 13: No. 3, 521-522(1973).

At the present time, the properties of the ionosphere are studied by using the methods of partial reflections and cross modulation, which permit systematic observations of the behavior of the D region. Certain questions pertaining to the method of partial reflection are discussed. (WDM)

1160 PERTURBATION OF F-LAYER DENSITY BY A SMALL-SCALE DYNAMO EFFECT. Vardanyan, Yu. S. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 442-445(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 518-520(1973).

It is well known that ionospheric currents, which are determined by the physical parameters of the ionosphere, in turn affect the magnitude of these parameters. The influence of longitudinal currents generated by the motion of neutral gas at the height of the E region on the structure of the F region is examined. In the framework of the small-scale dynamo theory, a multilayered system is discussed representing the atmosphere, the E and F regions, and the magnetosphere. (WDM)

1161 RAPID LATITUDINAL CHANGE OF THE AERONOMIC SITUATION IN THE EQUATORIAL IONOSPHERE IN THE PRESENCE OF VERY HIGH SOLAR ACTIVITY. Shobepkin, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 441-442(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 517(1973).

A detailed analysis of the conditions of development of the F1 layer at low latitudes, including the equator, shows their rapid change with latitude. Observational data from a network of ionospheric stations for Jan., Mar., and June 1958 were analyzed. It was found that the conditions of development of F1 improved markedly in the direction of the equator in both hemispheres and were considerably hindered in the regions 25 to 30°N and 15 to 20°S. (WDM)

1162 NONSTATIONARY DISTRIBUTION OF CHARGED PARTICLES IN THE UPPER ATMOSPHERE. Gvelesiani, A. I.; Khantadze, A. G. (Geophysics Inst., Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 438-440(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 514-516(1973).

A nonstationary solution of the ionization balance equation in the presence of pure diffusion was found by Khantadze, et al. (1972). An analogous problem with allowance for ionization, particle disappearance, and wind transport is examined. (WDM)

1163 ERRORS OF DETERMINATION OF IONOSPHERIC PARAMETERS AND CHARACTERISTICS OF IONOSPHERIC INHOMOGENEITIES FROM SIGNALS OF THE MAYAK RADIO STATION MOUNTED ON ARTIFICIAL EARTH SATELLITES. Migunov, V. M.; Solodovnikov, G. K.; Krokhmal'nikov, E. B. Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 357-360(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 411-415(1973).

It is shown that the use of first-approximation formulas of geometrical optics for obtaining data on the parameters of the ionosphere from recordings of radio signals from satellites leads to significant errors under certain conditions. The characteristics of ionospheric inhomogeneities, obtained from fluctuations of the parameters of radio signals from satellites, may be erroneous if the interpretation of the measurements is made in the approximation of geometrical optics. (auth)

1164 IMPEDANCE MODEL OF THE DAYTIME IONOSPHERE. Orlov, A. B.; Sternina, I. M. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 361-366(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 416-421(1973).

To approximate the dependence of the electron concentration on height, the expression $N(z) = A \operatorname{sh} \gamma(z - h)$ was chosen, which satisfactorily describes the experimental profiles of the lower portion of the daytime ionosphere; the limits of variation of parameters A, γ, and h were determined. It is shown that in calculations of the characteristics of propagation of the zero mode in the 6 to 30 kHz frequency range, a good approximation of the class of profiles outlined is some equivalent impedance wall with a height determined by the values of parameters a, γ, h, and with a fixed frequency dependence of the impedance. (auth)

1165 EFFECT OF VARIATIONS OF NEUTRAL COMPOSITION AT TURBOPAUSE LEVEL IN $n_e(h)$ PROFILES OF THE MIDLATITUDE F2-REGION. Fatkullin, M. N.; Muradov, A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 366-369(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 422-426(1973).

The effect of indeterminacy of the neutral composition at the turbopause levels on $n_e(h)$ profiles in the midlatitude F2 region was studied during afternoon hours. The summer and winter seasons were examined during a period of low solar activity. (auth)

1166 SEASONAL AND DIURNAL CHANGES IN THE HEIGHT AND ELECTRON DENSITY OF THE MAXIMUM OF THE F2-LAYER ON THE PLANETARY SCALE. Boenkova, N. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 369-374(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 427-432(1973).

The relationship of diurnal, seasonal, and latitudinal variations of h_mF_2 and N_mF_2 values during periods of high and low solar activity with a seasonal anomaly of the F2 layer were studied. At latitudes where the difference in the winter and summer values of h_mF_2 does not exceed 20 to 50 km, N_mF_2 in winter is greater than in summer, and at latitudes where the summer values of h_mF_2 considerably exceed the winter ones, the summer N_mF_2 values are higher than the winter ones. (auth)

1167 MORPHOLOGY OF SUBAURORAL $F2_s$. Mamrukov, A. P.; Zikrach, E. K. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 374-376(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 433-436(1973).

The morphological characteristics and space–time distribution of sporadic $F2_s$ in the F region, typical of latitudes with L ≈ 3 to 6 and related to disturbed periods are discussed. The space–time distribution of the probability of occurrence of $F2_s$ is given, and the dynamics of the $F2_s$ region are discussed. (auth)

1168 MEASUREMENTS OF AURORAL IONIZATION AT HIGH LATITUDES ON THE KOSMOS-348 SATELLITE. Dzhordzhio, N. V.; Ol'dekop, L. G.; Fedorova, N. I. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 377-380(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 437-441(1973).

An RIM-901m type ion analyzer used on Kosmos 348 for measuring ion temperatures and the horizontal ion density gradients is described. It was found that, under relatively quiet geomagnetic conditions ($K_p \sim 2$) in the auroral zone, $T_i \approx 1700°K$, and the corresponding energy fluxes of auroral electrons with E = 1, 4.5, 15 keV do not exceed 1 erg/cm² sec. For narrow structural formations, the ion densities were compared with fluxes of penetrating soft electrons. (auth)

1169 MODIFICATION OF THE METHOD OF IONOSPHERIC CROSS-MODULATION. Bezruchenko, L. I.; Belen'kii, M. I.; Tikhomirov, S. P. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 380-385(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 442-448(1973).

The possibility is discussed of combined use of observations of cross-modulation effects according to Smith's method and Fejer's classical method in solving the inverse problem of cross-modulation for the purpose of simultaneous determination of N(h) and ν(h) profiles on the basis of amplitude measurements alone for an investigated wave of one polarization. (auth)

1170 ONE OF THE POSSIBLE ANOMALOUS MODES OF SHORT RADIO WAVE PROPAGATION AT HIGH LATITUDES. Zhulina, E. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 386-390(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 449-454(1973).

The distribution of the amplitudes of signals passing at high latitudes through a zone of increased absorption was analyzed. A difference between the distribution obtained and the log-normal distribution was noted. The components of this distribution were isolated and evaluated in accordance with possible propagation mechanisms. The mechanism of anomalous propagation of radio waves, realized by means of intermediate reflections from the top of E_s, is discussed. (auth)

1171 REGULAR DIURNAL CHANGES IN THE AMPLITUDE OF vlf SIGNALS ON POLAR PATHS ASSOCIATED WITH THE MOTION OF THE EARTH RELATIVE TO THE AURORAL OVAL. Leonov, V. I.; Filippov, K. F. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 391-392(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 455-457(1973).

From an analysis of the recording of certain vlf stations it is concluded that there is a regular influence of the auroral oval on the conditions of vlf propagation. According to Fel'dshteyn, it is possible that on the basis of vlf recordings, the oval should be somewhat expanded. (auth)

1172 INFLUENCE OF IRREGULAR DISTURBANCES ON CHANGES IN THE PHASE VELOCITY OF vlf PROPAGATION AND THE EARTH'S ANGULAR VELOCITY OF ROTATION. Fleyer, A. G.; Vorob'ev, L. Ya.; Abramova, G. P. (Inst. of Metrology, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 393-396(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 458-462(1973).

The influence of chromospheric layers and associated changes in the geomagnetic field on vlf propagation and of changes in the Earth's angular velocity of rotation was studied. The interrelationship of changes in the phase velocity of vlf (phase delays) and the Earth's angular velocity of rotation in the case of irregular disturbances is indicated. A conclusion is reached on a correlation between both regular and irregular changes in phase delays of vlf and changes in the Earth's angular velocity of rotation and on the generality of the arguments of these changes. (auth)

1173 POSSIBLE ROLE OF INSTABILITY ASSOCIATED WITH THE NONISOTHERMAL NATURE OF THE IONOSPHERIC PLASMA. Biragov, S. B.; Gershman, B. N. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 397-400(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 463-467(1973).

The instability caused by the nonisothermal nature of the ionospheric plasma is discussed on the basis of a simplified approach to acoustic waves in the upper atmosphere. Estimates of the growth rates of disturbances suggest that such an instability may play a considerable role in the propagation of traveling ionospheric disturbances. An interpretation of certain important morphological relationships established for such disturbances can be given on the basis of ideas on the presence of the instabilities discussed. (auth)

1174 QUIET AND DISTURBED ELECTRON DENSITY PROFILES IN THE AURORAL ZONE IONOSPHERE. Bates, H. F.; Hansucker, R. D. (Univ. of Alaska, Fairbanks). Radio Sci.; 9: No. 4, 455-467(Apr 1974).

Electron density profiles of the auroral zone ionosphere for quiet, aurorally disturbed, and magnetic storm conditions were obtained by the Chatanika incoherent scatter radar (magnetic latitude 65.7°, L = 5.7). The magnetically disturbed F region was found to be reduced somewhat in maximum density and greatly modified in shape during daylight. Field-aligned ion transport caused by neutral winds is suggested as the cause of this behavior. The maximum density in the disturbed, dark ionosphere usually occurs in the auroral E layer, a thick layer with typical densities of 2 to 5×10^{11}e m^{-3} extending for several degrees of latitude. The auroral F layer has typical maximum densities of 0.5 to 2.0×10^{11}e m^{-3} at 300 to 400 km altitude; upward transport and secondary ionization by soft auroral primaries are suggested as the cause of the auroral F layer. During quiet periods between May and September, the high latitude F_1^n layer exists as a well-defined thick layer, sometimes with a distinct valley between it and the F_2^n layer. In addition to high D-region absorption accompanying disturbances, the observed high variability of the E and F regions can explain much of the behavior of transauroral hf propagation that has been noted by past studies. This paper reviews recent incoherent scatter results with regard to their implications to high latitude hf propagation. In particular, the importance of Joule heating effects on the F-region atmosphere is discussed in terms of their effect on the F layer. A few clear cases of spread-F in the College ionograms were found for times when the radar was observing near the ionosonde zenith. In all of the cases found, the maximum density of the layer corresponded to the inner edge of the spread trace; current scaling practice therefore appears to be correct. (auth)

1175 SHORT-PERIOD PULSATIONS OF THE VLF FIELD ON POLAR PATHS. Leonov, V. I. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 631-633 (1973).

Translated from Geomagn. Aeron.; 13: No. 4, 746-748(1973).

Observations of short-period pulsations of the vlf field on polar paths reveal characteristic statistical patterns that agree with modern views on the morphology of a polar substorm. Short-period pulsations of the vlf field are most frequent in the pre-midnight sector along the auroral oval and probably along the auroral zone in the morning sector. (WDM)

1176 UNIFICATION OF METHODS FOR COMPUTING IONOSPHERIC N(h) PROFILES ON A COMPUTER. Gulyaeva, T. L.; Kutiev, I. S.; Serafimov, K. B.; Shapiro, B. S. (Group on Space Physics, Sofia). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 637-638(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 752-753(1973).

One of the current problems in the processing of vertical sounding data is the conversion of ionograms to N(h) profiles. Computer methods for doing this are discussed. (WDM)

1177 EFFECT OF IONOSPHERIC CONDUCTIVITY ON THE OSCILLATION OF DP1 AND DP2 CURRENT SYSTEMS. Tashkinova, L. G.; Tverskoy, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 621-624(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 735-739(1973).

The oscillation of DP1 and DP2 current systems in an ionosphere which includes a ring of enhanced conductivity (auroral oval) is analyzed. Processes with a characteristic time comparable to

the charge relaxation period in the ionosphere but smaller than the period of longitudinal proton drift are investigated. The method of separation of variables is used to find the eigenvalues and eigenfunctions of this problem and the frequencies and attenuation decrement of the natural oscillations of the DP1 and DP2 systems. (auth)

1178 HYDROMAGNETIC WAVES IN A PLASMA WITH FINITE CONDUCTIVITY. Van'yan, L. L.; Zelenii, L. M.; Kozheynikov, A. A.; Yudovich, V. A. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 617-620(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 730-734(1973).

The structure of the longitudinal currents of a hydromagnetic wave from a source of the electric dipole type, immersed in a magnetospheric plasma, is investigated with allowance for finite conductivity along geomagnetic lines of force. It is demonstrated that at great distances the amplitude of the total current decreases as $\sim z^{-\frac{1}{2}}$. The emission characteristics of a source of finite dimensions are analyzed. (auth)

1179 CURRENT INSTABILITY OF ATMOSPHERIC GRAVITY WAVES. Gershman, B. N.; Grigor'ev, G. I. (Gorky Radio Physics Inst., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 513-517(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 604-609(1973).

The instability of acoustic and internal gravity waves, produced by ionospheric currents, is investigated. An instability criterion is obtained and analyzed. Instability can be associated with the excitation of ionospheric traveling disturbances, especially at high latitudes. (auth)

1180 DETERMINATION OF IONOSPHERIC REACTION RATE COEFFICIENTS FROM EXPERIMENTAL ELECTRON DENSITY VALUES. Velichanskii, B. N.; Klimov, N. N.; Krinberg, I. A.; Kuznetsova, G. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 518-521(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 610-614(1973).

The possibilities of a method for determining ionospheric reaction rate coefficients from experimental electron density values are examined. A special system of effective coefficients is used in the computations. It is demonstrated that the use of data on electron density variation alone makes it possible to find only two coefficients with sufficient accuracy, i.e., the weighted average coefficients of ion–molecule reactions and of dissociative recombination reactions. (auth)

1181 GENERATION OF VLF WAVES IN THE IONOSPHERE NEAR THE LOWER HYBRID RESONANCE. I. Vershinin, E. F.; Gorshkov, Yu. N.; Ponomarev, E. A.; Trakhtengerts, V. Yu.; Shapayev, V. I. (Gorky Radiophysical Inst., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 522-529(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 615-623(1973).

The generation mechanism of vlf waves in the region of the lower hybrid resonance, associated with beam instability during the passage of an electron flux through the ionospheric plasma, is analyzed. The dispersion properties of waves in this region are investigated with allowance for ion motion. It is demonstrated that vlf waves can be generated at ionospheric heights by a photoelectron flux. (auth)

1182 HYDROMAGNETIC GRADIENT WAVES IN THE IONOSPHERE. Khantadze, A. G. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 530-535(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 624-630(1973).

It is demonstrated that large-scale disturbances, representing a magnetic analog of long Rossby waves, must exist in the variable space of the geomagnetic field in the ionosphere. (auth)

1183 PLASMA INSTABILITIES IN THE REGION AHEAD OF A BODY RAPIDLY MOVING IN THE IONOSPHERE. Nagorskii, P. M. (Tomsk State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 536-539(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 631-634(1973).

The high-density region produced by the reflection of ions from a body is investigated. The possibility is indicated of the excitation of the lower hybrid resonance during the movement of reflected ions across a magnetic field. The results of numerical computations of the shapes of the boundary of the instability region and of increments in the growth of oscillations for various heights are presented. (auth)

1184 VERTICAL-LATITUDINAL DEVELOPMENT OF THE SEASONAL ANOMALY IN THE DAYTIME F2 REGION. I. Fatkullin, M. N.; Boyenkova, N. M.; Legen'ka, A. D.; Muradov, A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 544-549(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 640-646(1973).

The vertical-latitudinal distribution of the seasonal anomaly in the F2 region and in the topside ionosphere of the northern hemisphere in the afternoon at low solar activity is investigated. It is demonstrated that allowance for the seasonal variations of the neutral composition at the turbopause level makes it possible to construct a model that properly explains the main morphological characteristics of the manifestation of the seasonal anomaly under the indicated conditions. (auth)

1185 RELATION OF $F2_s$ WITH SOME CHARACTERISTICS IN THE IONOSPHERE AND MAGNETOSPHERE AT SUBAURORAL LATITUDES. Mamrukov, A. P.; Zikrach, E. K. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 550-552(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 647-650(1973).

The relation of the region of subauroral $F2_s$ with the main valley in the latitudinal variations of ionization in the ionospheric F region and with the projection of the plasmapause is investigated. A good space–time agreement between these phenomena is found. (auth)

1186 VARIATIONS IN THE ION COMPOSITION OF THE IONOSPHERIC E LAYER. Korsunova, L. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 553-556(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 651-654(1973).

The diurnal variations of NO^+/O_2^+ in the middle-latitude E region were obtained for quiet and disturbed conditions with allowance for the time-variable additional ionization source from the solution of continuity equations for positive ions (nonstationary conditions) and the equation of electric neutrality. The results of the computations agree with experimental data within a factor of 2. The variations in ion composition during a total solar eclipse are investigated. (auth)

1187 FORMATION OF THE E_s LAYER AND OF THE NIGHTTIME E REGIONS OF THE IONOSPHERE AT MIDDLE LATITUDES. Nesterov, V. P.; Chasovitin, Yu. K. (Inst. of Experimental meteorology, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 557-560(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 655-658(1973).

The vertical electron density profile in the ionospheric E region was determined with allowance for diffusion, the vertical drift of charged particles, the action of an additional ionization source, and of recombination for a specific wind profile. The computations were performed for two rocket flights in which the wind and electron density profiles were determined simultaneously. A satisfactory agreement was obtained between the experimental and computed electron density values. (auth)

1188 COMPARATIVE ANALYSIS OF ROCKET MEASUREMENTS OF $n_e(h)$ AND OF GROUND-BASED VERTICAL SOUNDING DATA. Gulyayeva, T. L.; Mal'tseva, O. A.; Freyzon, A. A.; Chasovitin, Yu. K. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 561-564(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 659-663(1973).

It is demonstrated that the height–frequency characteristics computed from the smoothed pattern of rocket $n_e(h)$ profiles agree with experimental ionograms obtained during rocket flights. On the other hand, computations of N(h) profiles from two magnetoionic components agree better with rocket data than computations based only on the ordinary component on an ionogram. (auth)

1189 PROPAGATION OF HIGH-FREQUENCY RADIO WAVES ON SOME PATHS DURING AURORAL STORMS. Zhulina, E. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 565-569(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 664-669(1973).

Data on field strength on three high-latitude radio paths during the auroral absorption storms of March 24 and 30, 1968, are analyzed. The dynamics of storm development and the simultaneous variations in the characteristics of hf propagation are described. Absorption data obtained with radiometers are compared with data derived from field strength measurements on the paths in question and found to agree well. A change in radiowave propagation conditions is found to be closely associated with the dynamics of auroral storm development. (auth)

1190 DETERMINATION OF THE VERTICAL PARAMETERS OF WAVELIKE IONOSPHERIC DISTURBANCES. Rybin, V. A. Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 570-572 (1973).

Translated from Geomagn. Aeron.; 13: No. 4, 670-673(1973).

Records are presented of the polarization fadings of signals

reflected from the F region during spaced-frequency reception with a large base. The presence of a time shift between characteristic segments of beats at different frequencies is demonstrated. It is confirmed that a large frequency spacing during operation on the nonsplit segment of the h'(f) characteristic makes it possible to determine the magnitude and direction of the vertical component of phase velocity and the period and vertical length of the disturbance wave. (auth)

1191 TWO TYPES OF RADIO EMISSIONS OF THE AURORAL IONOSPHERE AND IONOSPHERIC DISTURBANCES. Osipov, N. K.; Shevelev, Yu. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 573-575(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 674-677(1973).

Vertical sounding data show that the two main types of radio emission of the auroral ionosphere, i.e., emission of the burst type and of the type of a slowly varying component (SVC), are generated at different heights. The region of generation of the burst type is localized at heights below 110 km, whereas the generation of emissions of the SVC type is associated with processes at the level of the ionospheric F region. (auth)

1192 ORIENTATION OF AURORAL ARCS. Zaytseva, S. S.; Starkov, G. V.; Shevnina, N. F. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 579-582(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 682-686(1973).

Errors appearing in the determination of the orientation of discrete auroral forms are analyzed in relation to the conclusions derived previously regarding four orientations of auroral arcs. Renewed analysis of the same data revealed the existence of two types of auroras: one orientated along the oval and the other oriented in the direction toward the Sun. Multiple orientation of auroral forms occurs only during the active period of substorms, when any auroral orientation is possible. The methodological errors that led to the prior conclusion of the existence of four orientations of discrete auroral forms are discussed. (auth)

1193 THERMOSPHERIC HEATING. III. Thermospheric Heating by Short-Wave Solar Radiation at High Solar Activity. Izakov, M. N.; Krasitskii, O. P.; Morozov, S. K.; Yashchenko, I. A. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 583-588(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 687-693(1973).

The heating of the Earth's thermosphere by short-wave solar radiation in the Schumann–Runge continuum and the ionization continuum during high solar activity is computed for solar zenith angles from 0 to 92°. (auth)

1194 N_2^+ IONS IN THE EARTH'S ATMOSPHERE. Krasnopol'skii, V. A. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 589-593(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 694-699(1973).

Average relations of $[N_2^+]$ with h and $z_\odot$ at different solar activity are obtained from the results of 15 middle-latitude observations of N_2^+. The ionospheric values of the constants of dissociative recombination and of the reaction $N_2^+ + O \rightarrow NO^+ + N$ are computed. An estimate is given of the dependence of ionization rates on solar activity. (auth)

1195 ATOMIC NITROGEN AND NITROGEN OXIDE IN A DISTURBED IONOSPHERE IN THE HEIGHT INTERVAL 100 TO 200 KM. Dyadichev, V. N.; Kozlov, S. I. Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 594-597(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 700-704(1973).

The ion and electron kinetics and the variation with time of N and NO concentrations are analyzed for a disturbed ionosphere where air ionization α is much higher than normal, but $\alpha \ll 1$. The investigation is limited to time intervals when electron density in the disturbed ionosphere drops to natural values. The characteristic features of ion and electron kinetics are identified and the behavior, under these conditions, of the minor components of the atmosphere, N and NO, is determined. (auth)

1196 BEHAVIOR OF EXCITED ATOMS AND MOLECULES AT HEIGHTS OF 40 TO 300 KM IN THE UPPER ATMOSPHERE. Vlasov, M. N. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 598-601(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 705-710(1973).

The total distribution of excited particles at heights of 40 to 300 km in the daytime and at night is constructed. The daytime distribution has maxima at heights of 50 and 120 km. This distribution permits estimating the possible contribution of excited particles to the deviation of the gas in the upper atmosphere from thermodynamic equilibrium conditions and to the amount of internal energy of neutral particles. (auth)

1197 ROCKET-BORNE RADIOMETRIC MEASUREMENTS OF OH IN THE AURORAL ZONE. Rogers, J.W.; Murphy, R.E.; Stair, A. T. Jr.; Ulwick, J. C. (Air Force Cambridge Research Laboratories, Bedford, Massachusetts, 01730). J. Geophys. Res. 78: No. 30, 7023-7031(20 Oct 1973).

An Astrobee D rocket carrying a dual-channel radiometer (1.40- to 1.65-μm and 1.85- to 2.12-μm spectral band passes) was launched on March 6, 1972, at 0200 LT from Poker Flat, Alaska. The spectral band passes were chosen so that the lower (v=2, 3, 4, 5) and upper (v=7, 8, 9) vibrational levels of OH in the Δv=2 sequence could be monitored simultaneously. Launch criteria were established from ground-based radiometric observations that indicated a steady night airglow of 240 kR in the 1.40- to 1.65-μm band pass 2 hours prior to and throughout the flight. Altitude profiles of OH emission were derived from data from both channels and show OH to be layered, peak volume emissions occurring at 83.5 km. Under the assumption that $H+O_3 \rightarrow OH^* + O_2$ is the principal production mechanism, synthetic spectra were integrated over the instrument spectral response characteristics of the two radiometer channels. At altitudes above 83 km, quenching due to the reaction $OH^* + O \rightarrow O_2 + H$ is evident, which requires an atomic oxygen concentration of 10^{11} cm^{-3} at 83 km, increasing to 8×10^{11} cm^{-3} at 88 km. (auth)

Effects of Nuclear Detonations

1198 RADIOACTIVE HOT PARTICLES FROM THE RECENT CHINESE NUCLEAR WEAPONS TESTS. Moore, D.T.; Beck, J.N.; Miller, D.K.; Kuroda, P.K. (Department of Chemistry, University of Arkansas, Fayetteville, Arkansas, 72701). J. Geophys. Res. 78: No. 30, 7039-7050 (20 Oct 1973).

Variations in the number of individual fallout particles in the ground-level air at Fayetteville (36°N, 94°W), Arkansas, were measured for a period of about seven months after the 13th (January 7, 1972) and the 14th (March 18, 1972) Chinese nuclear test explosions. The fallout from the 13th test was typical of a tropospheric injection of debris and the effect lasted only for about five weeks, but the fallout from the 14th test persisted for about five months until August 1972, indicating that the fresh debris entered the stratosphere. The diameters of the particles ranged from about 0.1 to 7 μm in diameter, but a single unusually large particle (34 μm in diameter) was found during the night of March 23, 1972. Radiochemical studies were made on this 34-μm particle, in which the fission products belonging to the 'volatile' mass chains 89, 90, 91, 140, and 141 were highly depleted. The formation interval Ξ of this particle was calculated from the extent to which the volatile fission decay chains were depleted. A value very close to $\Xi=0$ (second) was obtained from the mass 91 chain, but no positive Ξ values could be calculated from mass 140 and 141 chains. This discrepancy was explained as being due to the difference in the melting points of the oxides of the elements belonging to the fission product decay chains (e.g., Rb, Cs, Sr, and Ba). (auth)

1199 ^{222}Rn, ^{210}Pb, ^{210}Bi, AND ^{210}Po PROFILES AND AEROSOL RESIDENCE TIMES VERSUS ALTITUDE. Moore, H.E.; Poet, S.E.; Martell, E.A. (National Center for Atmospheric Research, Boulder, Colorado, 80302). J. Geophys. Res. 78: No. 30, 7065-7075 (20 Oct 1973).

Results of measurements of ^{222}Rn, ^{210}Pb, ^{210}Bi, ^{210}Po, and ^{90}Sr concentrations in air at various altitudes up to 16 km over the continental United States are presented and discussed in relation to their sources and application as tracers for the estimation of the residence time of particles in the troposphere and lower stratosphere. It is concluded from the ratios of these isotopes that the simple steady state model does not apply to the long-lived radon daughters. Comparison of mean radioisotope concentration profiles with a theoretical model indicates that the mean aerosol residence time in the troposphere is less than 7 days and that most of the ^{210}Po in the troposphere is of continental surface origin. The magnitude of the increase in mean aerosol residence time with altitude within the troposphere appears to be less than a factor of 3. The mean aerosol residence time in the lower stratosphere is calculated to be about 1–2 months, approximately 10 times that of tropospheric aerosols. (auth)

1200 COMMENTS ON PAPER BY S. E. POET, H. E. MOORE, AND E. A. MARTELL, 'LEAD 210, BISMUTH 210, AND POLONIUM 210 IN THE ATMOSPHERE: ACCURATE RATIO MEASUREMENT AND APPLICATION TO AEROSOL RESIDENCE TIME DETERMINATION'. Marenco, A.; Fontan, J. (Centre de Physique Atomique, Université Paul Sabatier, Toulouse, France). J. Geophys. Res. 78: No. 30, 7149-7151 (20 Oct 1973).

Tropospheric residence times from measurement of long-lived radon decay products in air and precipitations are estimated. (auth)

1201 COMMENTS ON PAPER BY S. E. POET, H. E. MOORE, AND E. A. MARTELL, 'LEAD 210, BISMUTH 210, AND POLONIUM 210 IN THE ATMOSPHERE: ACCURATE RATIO MEASUREMENT AND APPLICATION TO AEROSOL RESIDENCE TIME DETERMINATION'. Moore, H.E.; Poet, S.E.; Martell, E.A. (National Center for Atmospheric Research, Boulder, Colorado, 80302). J. Geophys. Res. 78: No. 30, 7153-7154 (20 Oct 1973).

Troposphere residence times from measurement of long-lived radon decay products in air and precipitations are estimated. (auth)

1202 COMMENT ON PAPER BY S. E. POET, H. E. MOORE, AND E. A. MARTELL, 'LEAD 210, BISMUTH 210, AND POLONIUM 210 IN THE ATMOSPHERE: ACCURATE RATIO MEASUREMENT AND APPLICATION TO AEROSOL RESIDENCE TIME DETERMINATION'. Hartwig, S. (Fakultät für Physik der Universität Freiburg, D7800 Freiburg; Breisgau, Germany). J. Geophys. Res. 78: No. 30, 7155-7156 (20 Oct 1973).

Troposphere residence times from measurement of long-lived radon decay products in air and precipitations are estimated. (auth)

1203 COMMENT ON PAPER BY S. E. POET, H. E. MOORE, AND E. A. MARTELL, 'LEAD 210, BISMUTH 210, AND POLONIUM 210 IN THE ATMOSPHERE: ACCURATE RATIO MEASUREMENT AND APPLICATION TO AEROSOL RESIDENCE TIME DETERMINATION'. Moore, H.E.; Poet, S.E.; Martell, E.A. (National Center for Atmospheric Research, Boulder, Colorado, 80302). J. Geophys. Res. 78: No. 30, 7157-7157 (20 Oct 1973).

Tropospheric residence times from measurement of long-lived radon decay products in air and precipitations are estimated. (auth)

Magnetospheric Phenomena

1204 NON-DUCTED TWO-HOP WHISTLERS IN THE INNER MAGNETOSPHERE DEDUCTED FROM ROCKET MEASUREMENT. Hayakawa, M. (Nagoya Univ., Japan). Planet. Space Sci.; 22: No. 4, 638-642(Apr 1974).

The non-ducted whistler propagation in the inner magnetosphere is discussed using the broad-band vlf measurement on board the K-9M-26 rocket launched at 1703 hr JST on 24 August 1969 from Kagoshima Space Center (geomagnetic lat 20°N). A large number of whistlers which seemed to be two-hop whistlers originating in the northern hemisphere were observed. The main features of these whistlers are summarized: (1) their dispersion value is widely scattered in the range 55 to 75 $sec^{\frac{1}{2}}$, (2) their frequency spectra show a broad maximum in the frequency range 2 to 5 kHz and higher frequency components are likely to disappear. Attempts are made to interpret these properties in terms of ducted or non-ducted propagation. It is then found from the ray tracing studies that the measurements are satisfactorily explained by non-ducted propagation in the inner magnetospheric model with latitudinal density gradient such as the equatorial anomaly. (auth)

1205 COMPRESSED GEOMAGNETIC FIELD AS A FUNCTION OF DIPOLE TILT. Choe, J. Y.; Beard, D. B. (Univ. of Kansas, Lawrence). Planet. Space Sci.; 22: No. 4, 595-608(Apr 1974).

The currents on the precisely calculated magnetosphere surface previously reported have been integrated with the same accuracy as used in the surface calculation to give the magnetic field at 688 points within the magnetosphere for each of eight surfaces for the tilt of the Earth's dipole in steps of 5° between 0° and 35°. The magnetic fields have then been used to fit the coefficients of a 35 term spherical harmonic expansion of the scalar magnetic potential representing the field by the method of least squares fit. The coefficients for each of the eight surfaces were then represented as a power series in dipole tilt angle, λ so that the complete field can be given very conveniently for any λ. For $\lambda = 0$, the first two coefficients g_{10} and g_{21} are the dominant terms and the azimuthally dependent term g_{21} is 30% less than that calculated by Mead (J. Geophys. Res.; 69: 1181 (1964)) and Midgley (J. Geophys. Res.; 69: 1197 (1964)) from older less accurate surface and field calculations. (auth)

1206 NEAR EARTH MAGNETIC FIELD OF THE MAGNETOTAIL CURRENT. Choe, J. Y.; Beard, D. B. (Univ. of Kansas, Manhattan). Planet. Space Sci.; 22: No. 4, 609-615(Apr 1974).

In the forward part of the magnetosphere the distant tail current system approximates a magnetic quadrupole composed of two distorted adjacent solenoids. The current in the neutral sheet at this distance is accurately approximated as an infinitesimally thin current sheet. The magnetic field has been calculated near the Earth by integrating over the entire tail current system assuming the magnetotail is a cylinder of constant radius and that the tail current decreases with distance into the tail as $x^{-\frac{1}{2}}$. The field is then represented by a scalar potential expanded into spherical harmonics which may be conveniently added to the spherical harmonic expansion of the scalar potential representing the magnetopause current system. (auth)

1207 SOLAR CYCLE DEPENDENCE OF PERIODIC VARIATIONS IN GEOMAGNETIC K_P-INDEX. Abdel-Wahab, S.; Goned, A. (Ain Shams Univ., Cairo). Planet. Space Sci.; 22: No. 4, 537-544(Apr 1974).

The geomagnetic K_p index data for the 1932 to 1969 period have been investigated by means of a modified power spectrum technique on the basis of overlapping 2-yr intervals. The observed 27-, and 13.5-day periodicities show an obvious solar-cycle dependence through the whole period concerned. Also, periodicities in the range of 9 to 4 days have been observed through years of minimum and decreasing phases of solar activity. The periodicities observed are found to be related to the existence of variations in the interplanetary medium structure which modulates the geomagnetic activity. (auth)

1208 STRUCTURE OF THE EQUATORIAL ELECTROJET. Krylov, A. L.; Soboleva, T. N.; Fishchuk, D. I.; Tsedilina, E. E.; Shcherbakov, V. P. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 400-404(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 468-472(1973).

The structure of the cross section of the equatorial electrojet is investigated for geomagnetically quiet conditions during the solar activity minimum. The calculation is based on previously obtained expressions for currents and a model of conductivity distribution in the equatorial ionosphere. (auth)

1209 MAGNETIC-IONOSPHERIC EFFECT OF A SUBSTORM AT TBILISI OBSERVATORY. Pushkova, G. N.; Yudovich, L. A.; Petviashvili, V. I.; Fel'dshteyn, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 409-412(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 478-481(1973).

The variations in ionization density and heights at fixed levels at Tbilisi Observatory are computed for the magnetospheric substorm of October 21, 1964. The electric field intensities required for ionispheric currents to produce such variations are calculated from magnetic field variations, observed at the surface of the Earth. (auth)

1210 MAGNETIC LUNAR-SOLAR VARIATIONS, ACCORDING TO THE DATA OF VYSOKAYA DUBRAVA OBSERVATORY. Ivanov, N. A.; Panov, T. N. (Inst. of Geophysics, Sverdlovsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 415-418(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 486-490(1973).

Lunar-solar daily variations are investigated as a function of the seasons and of the phases of the Moon using harmonic analysis. It is found that the lunar-solar daily variation substantially reduces the daily variation of Z. (auth)

1211 MAGNETIC FIELD VARIATIONS DURING A RISE OF HEATED AIR IN THE ATMOSPHERE. Sorokin, V. M. Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 419-422(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 491-495(1973).

The diamagnetic disturbance of the geomagnetic field during the expansion of a rising heated air mass is investigated. The time dependence of the magnetic field produced by the magnetic moment arising from the interaction of an expanding, conductive gas with the geomagnetic field is obtained. The time of change and the maximum value of the magnetic field are estimated. (auth)

1212 RELATIONSHIP BETWEEN THE COEFFICIENTS OF SKEWNESS AND EXCESS OF AN ANOMALOUS MAGNETIC FIELD. Lugovenko, V. N.; Pronin, V. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 423-425(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 496-499(1973).

The relationship between the coefficients of excess and skewness is investigated for an anomalous magnetic field. This relationship is approximated by a second-order parabola. The effect of the location of the region of investigation on this relationship is examined. (auth)

1213 SPATIAL DISTRIBUTION OF TRAPPED PARTICLES IN THE OUTER MAGNETOSPHERE. Kasimov, U.; Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 435-437(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 511-512(1973).

The distribution function on the night side of the magnetosphere was calculated from a given radial particle distribution at the equator on the day side. The distribution over L_d (the equatorial distance to the line of force from the day side in Earth radii) was examined. (WDM)

1214 GEOMAGNETIC TAIL IN EXPERIMENTS WITH A THREE-DIMENSIONAL TERRELLA. Dubinin, E. M.; Podgornyi, I. M. Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 457-459(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 532-534(1973).

An experiment was set up on the interaction of artificial solar wind with the magnetic field of a three-dimensional terrella and measurements were performed of the magnetic-field configuration on the night side. (W.D.M.)

1215 DIAGNOSTICS OF THE INTERPLANETARY MAGNETIC FIELD FROM GROUND-BASE DATA ON Pc2-4 MICROPULSATIONS. Gul'el'mi, A. V.; Bol'shakova, O. V. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 459-461(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 535-536(1973).

A comprehensive statistical method is proposed for diagnosing the magnitude of the interplanetary magnetic field ahead of a shock front on the basis of ground-based observations of Pc2-4 pulsations. (W.D.M.)

1216 SEASONAL CHANGES OF VARIATIONS OF THE Z COMPONENT IN THE POLAR REGION IN CONNECTION WITH THE SIGN OF THE Y_{SE} COMPONENT OF THE INTERPLANETARY MAGNETIC FIELD. Sumaruk, P. V.; Fel'dshteyn, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 469-470(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 545-546(1973).

To determine the nature of the course of geophysical phenomena in the polar region, for example the characteristics of field variations, it is necessary to divide the periods studied not according to the sign of the sector but according to the direction of the Y_{SE} component of the interplanetary magnetic field. (W.D.M.)

1217 SOUTHERN COMPONENT OF THE INTERPLANETARY MAGNETIC FIELD AND MAGNETOSPHERIC SUBSTORMS. Ivanov, K. G.; Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 412-415(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 482-485(1973).

The lag of the explosive phase of a substorm behind the instant of southward reversal of the normal component of the interplanetary field is investigated on the basis of average 5-min observations of the interplanetary magnetic field components and magnetograms of ground-based stations. It is found that the lag (measured ±10 min) ranges from 1 hr 10 min to 4 hr 40 min. According to the reconnection scheme, the lag of the explosive phase is about $\Phi/F\overline{v}$, where Φ is the specific magnetic flux, reconnecting during the growth phase, $\overline{v}$ is the reconnection speed, and F is the magnetic field in the streamline-flow region. According to estimates, the lag is ~2 to 3 hours, which agrees with experiment. (auth)

1218 SOFT ELECTRON FLUXES IN THE UPPER ATMOSPHERE OF THE POLAR REGION. Tulinov, V. F.; Zhuchenko, Yu. M.; Lipovetskii, V. A.; Tulinov, G. F.; Feygin, V. M. (Central Aerological Observatory, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 3, 437-438(1973).

Translated from Geomagn. Aeron.; 13: No. 3, 513(1973).

Results are reported of measurements of low-energy electrons with a channel electron-multiplier detector during the launch of the MR-12 meteorological rocket in the polar region (Mar. 4, 1972, Heiss Island). (WDM)

1219 AURORAL ELECTRONS AND THE MAGNETIC SUBSTORM OF DECEMBER 24, 1968. Turbin, Yu. G.; Van'yan, L. L. Gal'perin, Yu. I.; Debabov, A. S.; Spival, V. A.; Fedorova, N. I. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 606-611(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 716-722.

The magnetic disturbance due to an electric current produced by auroral electrons is estimated from electron flux measurements during the flight of Kosmos 261 above the region of the auroral electrojet. A model of current inflow and outflow from the ionosphere is used. It consists of two layers that are displaced from each other along the meridian. The estimate gives a magnetic disturbance of ~30γ, whereas $\Delta H > 300\ \gamma$ was observed on Earth. (auth)

1220 DRIFT OF RADIATION-BELT PARTICLES DURING A SUBSTORM. Bondareva, T. V.; Tverskaya, L. V. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 612-616(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 723-729(1973).

The drift trajectories of charged particles in a dipole magnetic field and a nonstationary electric field that varies sinusoidally are analyzed. The results are used to investigate the acceleration of particles in radiation belts during a substorm. (auth)

1221 RADIAL DISTRIBUTION OF OUTER-BELT PROTONS. Gubar, Yu. I.; Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 625-627(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 740-741(1973).

A stationary distribution function of trapped particles was investigated previously (1973) as a function of adiabatic invariants. It was assumed that the distributions are independent and similar in individual invariants. An independent distribution in the third invariant is observed in the radiation belt of low-energy protons. This independence is satisfied on the average over a large time interval also for electrons of different energies. The exponential distribution for the third invariant is a good approximation to the observed distribution of low-energy protons. The steep drop of the distribution function toward the Earth is obtained directly from the exponential distribution in the third invariant in a dipole magnetic field rather than on account of losses. The great stability of the distribution is attributable to the fact that it is determined mainly by the geomagnetic field. However, the distribution can become established through diffusion. The particle distribution in the third invariant with definite values of the first two invariants was investigated. Here the further corollaries of the exponential distribution in adiabatic invariants I_i are reported. The results obtained are compared with experiment. (WDM)

1222 ORIGIN OF RELATIVISTIC ELECTRONS NEAR L = 2.8. Gorchakov, E. V.; Ternovskaya, M. V.; Getselev, I. V. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 627-629(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 742-744(1973).

The results of measurements between December 21 and 29, 1966, of relativistic electrons with the Cherenkov counter installed on Kosmos 137 were discussed previously (Gorchzkov, et al. 1969, 1972). It was demonstrated that electrons with energies $E_e \geq 7$ MeV (energy threshold I) were recorded in the region of trapped radiation near $L \approx 2.8$. These electrons were not recorded by threshold III ($E_e \geq 15$ MeV). The time and space dependence of electron intensity is investigated on the basis of the data of energy threshold III and the time dependence of the intensity of relativistic electrons recorded by threshold I in a broader range of L, one of the possible mechanisms of formation of the narrow belt of energetic electrons is examined. (WDM)

1223 LOW-ENERGY PROTONS IN THE UPPER ATMOSPHERE. Tulinov, V. F.; Lipovetskii, V. A.; Feygin, V. M. Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 630-631(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 745(1973).

The results of rocket measurements of low-energy proton fluxes at heights of 100 to 180 km at middle latitudes are reported. The first rocket measurements of low-energy protons in the upper atmosphere at middle latitudes were performed in 1969. (WDM)

1224 RELATION OF THE EXCITATION OF TYPE Pi1 AND Pc1 GEOMAGNETIC PULSATIONS WITH MAGNETOSPHERIC SUBSTORMS. Troitskaya, V. A.; Matveeva, E. T.; Kalisher, A. L. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 640-642(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 755-756(1973).

Type Pi1 and Pc1 geomagnetic pulsations in the course of the development of a substorm were investigated. Observations from Sorga (1968 and 1969) were used and in some cases the data from Borok, Lovozero, Chelyuskin, Tixie, and Kerguelen. (WDM)

1225 CONJUGATION OF LONG-PERIOD PULSATIONS OBSERVED IN THE POLAR CAP. Korobeynikov, V. G.; Men'shutina, L. N. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 13: No. 4, 643-644(1973).

Translated from Geomagn. Aeron.; 13: No. 4, 757-758(1973).

One of the conclusions derived from Siscoe's model, i.e., that pulsations are conjugated by periods, is confirmed in the first approximation. Consequently, the assumption that a standing wave can be the source of pulsations observed in the polar-cap auroral zone is also confirmed. (WDM)

PHYSICS (ATOMIC AND MOLECULAR)

1226 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON ATOMIC, MOLECULAR, AND SOLID-STATE THEORY AND QUANTUM BIOLOGY, SANIBEL ISLAND, FLORIDA, JANUARY 21–27, 1973. Loewdin, P. (Ed.). Int. J. Quant. Chem., Symp.; No. 7, 1-664(1973).

The conference included 72 papers. Separate abstracts were prepared for 16 papers. Other papers were outside the scope of NSA. (JFP)

For abstracts of individual papers see: 1234–1238, 1272, 1273, 1348–1354, 1487, and 1518.

Beams and Their Reactions

Refer also to abstract 341.

1227 ION BEAM ASPECTS OF A COMPACT POLARIZED ION SOURCE. Keane, J. A. Columbus, OH; Ohio State Univ. (1973). 163p. University Microfilms Order No. 74-3217.

Thesis (Ph.D.).

A compact atomic beam type ion source for the production of polarized protons and deuterons was constructed for the pressurized high voltage terminal of the Ohio State University 5.5 MeV Van de Graaff accelerator. The atomic beam is prepared for ionization by first using a strong field sextupole magnet to separate atoms having electron spin components, $m_j = \pm 1/2$, and then by effecting radio frequency transitions between hyperfine Zeeman levels using the adiabatic fast passage method. The beam is ionized in a strong field ionizer having an average axial field of 850 G and is focussed to a crossover at the center of a Wien filter by a three element immersion lens and serves as an object point for injection into the accelerator tube by a main lens. This dissertation is concerned with a detailed description of the ion beam, beginning with its origination in the ionizer. The details of the author's design, construction, and testing of the ionizer are discussed. The theory concerned with the ion optics of the ion source is reviewed. Deuteron tensor polarization in the range of -0.30 ± 0.05 to -0.35 ± 0.05 was measured with a test bench accelerator, and a tensor polarization of 0.16 ± 0.04 was measured when the ion source was installed in the pressurized terminal. At that time, no proton polarization was detected. (Diss. Abstr. Int., B)

1228 INTENSE ELECTROMAGNETIC FIELD AND MULTIPHOTON PROCESSES. Gontier, Y.; Rahman, N. K. (CEN de Saclay, Gif-sur-Yvette, France). Lett. Nuovo Cim.; 9: No. 14, 537-540(6 Apr 1974).

The comprehensiveness and simplicity of a theoretical approach for treating various multi-photon processes are emphasized. It is shown that a unitary transformation of the Shroedinger equation can be used for calculating multiphoton amplitudes for two kinds of physical situations: charged particle scattering in a strong electromagnetic field and many-electron atom and multiphoton processes. (LBS)

1229 TWIN ANODE ELECTROSTATIC ION GUN WITH THERMIONIC ELECTRON INJECTION. Rushton, G. J.; Fitch, R. R. (Aston Univ., Birmingham, Eng.). J. Phys., E (London); 7: No. 4, (Apr 1974).

The operating voltage and pressure of the twin anode electrostatic ion gun have been reduced and the range of applications extended by incorporating a thermionic source of electrons. The construction and performance of the ion gun is described. The energy of the emerging ion beam has been reduced and thus the ions will produce less structural damage to any specimen under ion bombardment. This ion gun should have applications in ultra high vacuum. (auth)

1230 COMPRESSION OF INTENSE RELATIVISTIC ELECTRON BEAMS. Davitian, H. E. Ithaca, NY; Cornell Univ. (1973). 186p. University Microfilms Order No. 73-31,800.

Thesis (Ph. D.).

Four techniques for the radial compression of an intense relativistic electron beam are investigated. Optimum energy densities, efficiencies, beam areas, and gains in energy density obtained with each technique and the conditions under which the optimum results are obtained are reported. Physical mechanisms underlying the observations are discussed. A Marx generator–Blumlein pulse-forming network system is employed to produce a 300 keV, 35 kA, 55 ns beam of relativistic electrons. The four approaches to beam compression studied are: converging magnetic fields, propagation of pinched beams, cones—the beam is injected into the large diameter end of a 2.5° or 4° full angle metallic cone, and rod cathode. (Diss. Abstr. Int., B)

1231 IMPROVEMENTS TO ION SOURCES AND THE CRUCIBLE SYSTEM ENABLING THE HIGH SATURATION VAPOR PRESSURE ELEMENTS USED IN ION SOURCES TO BE MAINTAINED AT THEIR VAPORIZATION TEMPERATURE. Kervizic, J.; Masic, R.; Warnecke, R. J. (to Thomson-CSF). French Patent 2,165,172. 21 Dec 1971. 5p. (In French).

A crucible system for a double ionization chamber ion source is presented. The system described incorporates a graphite enclosure fixed to a support. This enclosure is provided with holes for the passage of the ion beam from an ionization chamber and also with the appropriate heating means. The special features of the system are the way in which its cooling and heating system operate in conjunction with one another and the way in which the temperature is controlled and adjusted for maintaining the high saturation vapor pressure chemical elements in the enclosure at their vaporization temperatures. (FR)

1232 CHANGEOVER DEVICE FOR THE CRUCIBLES USED IN CERTAIN TYPE OF ION SOURCES. Kervizic, J.; Masic, R.; Warnecke, R. J. (to Thomson-CSF). French Patent 2,165,265. 23 Dec 1971. 6p. (In French).

A changeover device for the crucibles of a particular type of ion source having two ionization chambers is described. It features a sealed magazine which is rigidly connected to one of the ionization chambers by an intermediate chamber; a movable drum having several compartments designed to house the crucibles; means for rotating this drum; means for translating the crucibles parallel to the axis of the device; means for adjusting and controlling the temperature of the selected crucible introduced into the ionization chamber, and means for adjusting and controlling the temperature varying with the position of the drum, i.e., the element contained in the crucible. (FR)

Atomic and Molecular Properties

Refer also to abstracts 642, 1295, 1305, 1319, and 1339.

1233 (ANL-Trans-951) COHERENT EXCITATION BY THE PERIODIC FIELD OF CRYSTAL. Okorokov, V. V.; Tolchenkov, D. L.; Cheblukov, Yu. P.; Khizhyakov, I. S.; Lapickii, Yu. Ya.; Ifezov, G. A.; Zhukova, Yu. N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). Apr 1974. Translation of ITEF-19. 33p. Dep. NTIS $4.75.

The experimental results confirming the existence of the effect of coherent excitation of levels of He^+ ions in flight through a crystal are presented. The slowing-down effects of particles in a crystal and of thermal vibrations of crystal atoms on the possibilities of observing coherent atomic and nuclear level excitation were examined. Qualitative considerations regarding some physical possibilities of the effect were expressed. (auth)

1234 ACCURATE METHOD FOR SOLUTION OF ONE-ELECTRON PERTURBATION EQUATIONS. Josefson, C. M.; Musulin, B. (Southern Illinois Univ., Carbondale). Int. J. Quant. Chem., Symp.; No. 7, 117-122(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

An accurate nonvariational method for solution of one-electron nonhomogeneous equations arising in time-dependent perturbation theory is presented. The frequency-dependent dipole polarizability of hydrogen is calculated as an example. (auth)

1235 SOLUTION OF THE SCHROEDINGER EQUATION FOR H_2 IN TERMS OF A WAVE FUNCTION LEAST DISTORTED FROM A PRODUCT OF ATOMIC WAVE FUNCTIONS. Adams, W. H. (Rutgers—The State Univ., New Brunswick, NJ). Int. J. Quant. Chem., Symp.; No. 7, 127-133(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

Two-electron wave functions which are least distorted from a product of hydrogen atom wave functions were calculated for the hydrogen molecule at several nuclear separations by solving an equation proposed previously. From each wave function determined from this equation, two Schroedinger equation eigenfunctions were obtained by symmetry projection. The properties of the author's equation and its solutions for H_2 are discussed. (auth)

1236 THEORETICAL DETERMINATION OF H_2 GROUND-STATE SPECTROSCOPIC PROPERTIES. Wu, F. M.; Beckel, C. L. (Univ. of New Mexico, Albuquerque). Int. J. Quant. Chem., Symp.; No. 7, 135-141(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

Dunham coefficients a_i are determined for the H_2 ground-state potential calculated by Kolos and Wolniewicz. From these a_i Born–Oppenheimer spectroscopic constants Y_{ij} are found. Adiabatically corrected Y_{ij} are also calculated. An inaccuracy in a virial theorem result is described. From Kolos–Wolniewicz eigenenergies theoretical values of B_v, D_v, and H_v are determined. The theoretical Y_{ij}, B_v, D_v, and H_v are compared with experimental values. (auth)

1237 RELATIVISTIC HARTREE–FOCK COMPTON PROFILES. Mendelsohn, L. B. (Polytechnic Inst. of Brooklyn); Biggs, F.; Mann, J. B. Int. J. Quant. Chem., Symp.; No. 7, (1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

Theoretical analysis and computer codes were developed for calculating Compton profiles from numerical nonrelativistic and relativistic Hartree–Fock wave functions. Calculations are performed in uranium, and results for nonrelativistic and relativistic electron densities, momentum distributions, and Compton profiles for individual orbitals are presented and compared. Large relativistic effects on the Compton profiles of the s and p orbitals are observed, even for orbitals with large principal quantum numbers. The 7s J(0) relativistic value lies 15.2% below the nonrelativistic Hartree–Fock value. The total uranium profile is decreased by 6.60% at the center when a relativistic wave function is used. Cited profile results for other atoms indicate that relativistic calculations may be necessary for atoms of xenon or for even smaller atoms. (auth)

1238 TREATMENT OF CORRELATION EFFECTS IN SECOND-ORDER PROPERTIES. Bartlett, R. J. (Aarhus Univ., Denmark); Bellum, J. C.; Braendas, E. J. Int. J. Quant. Chem., Symp.; No. 7, 449-462(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

A CI perturbation approach previously shown to yield a series of rapidly converging approximations to the full CI energies and eigenvectors is extended to provide a natural formulation for the treatment of correlation effects in second-order properties. The method, which is found to have several computational advantages is illustrated by a calculation of the parallel component of the static polarizability for H_2. (auth)

1239 ELECTRON EXCITATION OF THE 2p STATE OF ATOMIC HYDROGEN NEAR THRESHOLD. Williams, J. F.; Willis, B. A. (Queen's Univ., Belfast). J. Phys., B (London); 7: No. 3, L61-L65(21 Feb 1974).

The absolute total cross section for excitation of the 2p state of atomic hydrogen by electrons is examined in detail in the first electron volt above the 2p threshold. Only a single resonant state (^1P) is found just above the threshold. An absolute value of the total 2p excitation cross section of $0.276^{+0.030}_{-0.028}$ πa_0^2 at 11.0 eV is determined by calibration of the apparatus relative to the differential elastic scattering cross section value of 0.727 πa_0^2 sr^{-1} at 60° and 8.70 eV and by calibration of the Lyman alpha detector. These experimental measurements do not require any corrections for cascade radiation and do not depend upon any theoretical calculations for normalization. The present values agree well with the various three state close coupling calculations but disagree with the six-state close coupling calculations as well as all previous experimental values which were normalized to the Born approximation calculations. (auth)

1240 THEORETICAL STUDY OF THE EFFECT OF THE MOLECULAR STRUCTURE ON THE ELECTRONIC TRANSITION PROBABILITIES AFTER THE ^{14}C β-DECAY. Raadschelders-Buijze, C.; Roos, C. L.; Ros, P. (Vrije Univ., Amsterdam). Chem. Phys. (Amsterdam); 1: No. 5, 468-475(1973).

Using wave functions from ab initio and INDO calculations, the probability that a molecule, of which a carbon atom undergoes β-decay, passes from its ground state to the ground state of the daughter ion is studied. It is shown that the electronic part of this transition probability is almost independent of the molecular structure and of electronic factors like aromaticity. Furthermore, the effect of β-decay on the electronic structure of a molecule turns out to be restricted to the direct environment of the decaying carbon atom. (auth)

1241 RELATIVISTIC Z-EXPANSIONS FOR EXCITED STATES OF He AND Li. Snyder, R. (Queen's Univ., Belfast). J. Phys., B (London); 7: No. 3, 335-341(21 Feb 1974).

Calculations of first-order relativistic Z-expansion coefficients are extended to states in the He and Li isoelectronic sequences containing 3p and 4p electrons. It is noted that the Briet interaction contributes only through exchange terms when dealing with the jj-configuration average of two nonequivalent electrons. Second-order coefficients for excited two-electron states are extrapolated from the variational calculations of Accad et al. (Phys. Rev. A; 4: 526-536(1971)). Z-expansion predictions of the $1s^2np$ ^2P doublet splittings (n = 2, 3, 4) are compared to experimental and to other theoretical results. (auth)

1242 L_1 SUBSHELL YIELDS OF ELEMENTS WITH Z = 74, 75, 77, 79, AND 90. Salgueiro, L.; Ramos, M. T.; Escrivao, M. L.; Martin, M. C.; Ferreira, J. G. (Lisbon Univ.). J. Phys., B (London); 7: No. 3, 342-348(21 Feb 1974).

Coster–Kronig (f_{12}) and fluorescence (ω_1)L_1 subshell yields of tungsten, rhenium, iridium, gold and thorium were determined by comparing the relative intensities of the L_2 satellites with the L_1 and L_2 x ray lines. The experimental results are: W $f_{12} = 0.260 \pm 0.063$, $\omega_1 = 0.106 \pm 0.023$; Re $f_{12} = 0.286 \pm 0.070$, $\omega_1 = 0.095 \pm 0.020$; Ir $f_{12} = 0.157 \pm 0.035$, $\omega_1 = 0.096 \pm 0.020$; Au $f_{12} = 0.207 \pm 0.051$, $\omega_1 = 0.098 \pm 0.020$; and Th $f_{12} = 0.086 \pm 0.020$, $\omega_1 = 0.108 \pm 0.022$. The values of f_{12} are independent of previous work on fluorescence yields, but it was necessary to assume values for ω_2 in order to obtain the results of ω_1. (auth)

1243 SEMI-EMPIRICAL π-ELECTRON CALCULATIONS OF PROTON, NITROGEN, AND FLUORINE HYPERFINE COUPLING CONSTANTS. Hirst, D. M.; Treweek, R. F.; Vilain, C. A. (Univ. of Warwick, Coventry, Eng.). Chem. Phys. (Amsterdam); 1: No. 2, 149-155(1973).

The application of the parameterization scheme of Beveridge and Hinze for π-electron molecular orbital calculations to spin density calculations is examined for a series of radicals including anions derived from pyridine derivatives, substituted styrenes, aromatic carboxylic acids, benzonitriles and fluoronitrobenzene derivatives and azabenzyl and fluorobenzyl radicals. The method correlates proton hyperfine coupling constants satisfactorily and gives a reasonable correlation of nitrogen coupling constants. The application to fluorine couplings is less satisfactory. (auth)

1244 EXTENDED AVERAGE ENERGY PERTURBATION CALCULATION OF THE $2s^2$ AND $2p^2$ ^1S RESONANCE STATE ENERGIES OF TWO-ELECTRON ATOMS. Eliezer, I. (Tel Aviv Univ., Israel); Moualem, A.; Kirtman, B. Chem. Phys. (Amsterdam); 1: No. 4, 362-370(1973).

An extended average energy (EAE) calculation of the $2s^2$ and $2p^2$ ^1S resonance state energies of two-electron atoms is carried out. One takes the bare-nucleus Hamiltonian as the initial approximation, and the zeroth-order degeneracy is treated by van Vleck perturbation theory. For both H^- and He the lower state energies agree quite well with experiment while the upper state is about 1 to 2 eV too high. The results for He are comparable in accuracy to those obtained by the 1/Z Hartree–Fock perturbation method. A brief concluding discussion of ways to improve the simple EAE technique is presented. (auth)

1245 SIMPLE DEMONSTRATION OF THE ORIGIN OF HUND'S RULE FOR THE HELIUM 2S AND 2P STATES. Harcourt, R. D.; Harcourt, A. (Univ. of Melbourne). Chem. Phys. (Amsterdam); 1: No. 3, 238-243(1973).

Using hydrogenic atomic orbitals in the wave function 1s(1)2p(2), and simple "local" energy calculations ($E_{loc} = H\phi/\phi$), the origin of Hund's rule of maximum spin multiplicity is examined for the (2^3P) and (2^1P) states of the helium atom. In agreement with other recent studies, it is found that the greater electron–nuclear attraction stabilizes the triplet state relative to the singlet state. Similar conclusions pertain for the (2^3S) and (2^1S) states when Slater 2s orbitals are used in the 1s(1)2s(2) wave functions. For each of the calculations, it is not necessary to take account of electron indistinguishability. (auth)

1246 SECONDARY IONIZATION MECHANISMS IN AN E × B DISCHARGE IN HYDROGEN. Fletcher, J.; Walsh, T. I. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys.; 26: No. 6, 761-769(Dec 1973).

A study of the secondary ionization mechanisms operative in an E × B Townsend discharge in hydrogen was made by investigating the formative time lag to electrical breakdown in such discharges. Comparison of the experimental data with predictions from a theoretical model enables the secondary mechanisms to be distinguished and their separate contributions to be estimated. The results so obtained are compared with those derived from the equivalent pressure concept. (auth)

1247 APPLICATION OF THE DISTINGUISHABLE ELECTRON METHOD. Chong, D. P. (Univ. of British Columbia, Vancouver); Scott, W. R.; Yue, C. P.; Wang, P. S. C.; Benston, M. L.; Palke, W. E. Int. J. Quant. Chem.; 8: No. 1, 137-150 (Jan 1974).

In order to make a better assessment of the distinguishable electron method developed by Kirtman and co-workers, the method was applied to some two-electron atoms and to H_2 and LiH. The results lend support to the contention held by Kirtman and co-workers that the distinguishable electron method is a practical way of calculating reasonably accurate physical properties. (auth)

1248 FLOATING ONE-CENTER PERTURBATION TREATMENTS FOR H_2^+-LIKE MOLECULES BASED ON SCREENED HYDROGEN ATOM OR MOLECULAR PUFF UNPERTURBED PROBLEMS. Ali, M. K.; Meath, W. J. (Univ. of Western Ontario, London). Int. J. Quant. Chem.; 8: No. 1, 119-136(Jan 1974).

Various floating one-center perturbation schemes are developed for H_2^+-like molecules. Previous work for the "1s" hydrogen atom approach is extended through third order in the energy. In the molecular puff approach an exact "closed form" solution is obtained for the zeroth-order problem, which corresponds to a double layer molecular puff. Semi-analytical results for the first-order correction to the floating molecular puff wave function and for the energy through third order are developed which offer a convenient alternative to previous approaches. Explicit calculations for ground state H_2^+ show that for $R > 3a_0$ the "1s" and the more complicated "puff" treatments are equivalent and that neither the "1s" nor the molecular puff function is an adequate zeroth-order wave function for the important intermediate values of R. The usefulness of some of these methods in a variety of problems, where one-center zeroth-order wave functions do appear to be adequate, is discussed briefly. (auth)

1249 VARIATION OF THE POLARIZABILITY OF THE HYDROGEN MOLECULE ION AND THE HYDROGEN MOLECULE WITH INTERNUCLEAR SEPARATION. Zeroka, D. (Lehigh Univ., Bethlehem, PA). Int. J. Quant. Chem.; 8: No. 1, 91-95 (Jan 1974).

The variation of the polarizability of H_2^+ and H_2 with internuclear separation $R = 1.6 - R = 2.4$ a.u. for H_2^+ and $R = 1.0 - R = 2.0$ a.u. for H_2 is determined using a variational method suggested by Das and Bersohn. From these data, values of $\langle\alpha\rangle_{0,J}$ for which nuclear motion due to zero point vibration and centrifugal stretching is taken into account, are calculated at 300°K. The relative percent increases of the motion averaged values compared to the equilibrium values are as follows: 10.50% for H_2^+ and 6.52% for H_2. (auth)

1250 ACCURATE ANALYTICAL SELF-CONSISTENT FIELD WAVE FUNCTIONS FOR Tm^{2+} AND Tm^{3+}. Damommio, A. (Texas Christian Univ., Fort Worth); Synek, M. Int. J. Quant. Chem.; 8: No. 1, 73-78(Jan 1974).

The analytical expansion self-consistent field method was employed to perform ab initio calculations for the ground states of the rare-earth ions, Tm^{2+}, $4f^{13}$, ^2F, and Tm^{3+}, $4f^{12}$, ^3H, (Z = 69). In each case the total number of basis functions used in the analytical expansions was 29, distributed as follows: 10, 8, 5, and 6, for the symmetries s, p, d, and f, respectively. All of the orbital exponents of the basis functions were optimized repeatedly, to the extent of the single-precision computer representation. Values of $\langle r^n\rangle$ for the 4f orbital of both ions are also presented, for the convenience of experimentalists. (auth)

1251 PERTURBATIVE AB INITIO CALCULATIONS OF INTERMOLECULAR ENERGIES. II. The He ... He Problem. Daudey, J. P.; Malrieu, J. P.; Rojas, O. (CNRS, Paris). Int. J. Quant. Chem.; 8: No. 1, 17-28(Jan 1974).

The ground state energy of the He_2 system is calculated according to the techniques described previously, without assuming the constancy of the intraatomic correlation energies. The second-order results do not present an attractive region; the S^2 decrease of the intraatomic correlation corrections is larger than the attractive interatomic correlation corrections. The further orders reverse progressively the situation and finally give a qualitatively correct potential curve after the fifth order. Reaching almost exact solutions in the considered basis, one can demonstrate that the intermolecular calculation of the system A + B in the union of the basis for A and B involves an energy decrease which simply represents the effect of the extension of the basis set; and that a proper intermolecular calculation must compare the A + B energy with the A and B energies calculated in conveniently extended basis sets including the vacant MO's of the partner. (auth)

1252 EXISTENCE OF DISCRETE SPECTRUM IN HYDROGEN MOLECULAR ION. Shastry, C. S. (Birla Inst. of Tech. and Science, Pilani, India). Progr. Theor. Phys. (Kyoto); 50: No. 2, 450-458(Aug 1973).

A trace analysis of the kernel of the Lippmann–Schwinger equation is carried out to determine the sufficient condition for the existence of bound states of the hydrogen molecular ion. This has implications in the study of three particle Coulomb systems. (auth)

1253 ELECTRONIC SPECTRUM OF LuD. Effantin, C.; D'Incan, J. (Univ., Lyon). Can. J. Phys.; 52: No. 6, 523-535 (15 Mar 1974). (In French).

The electronic spectrum of LuD was excited in a Lu_2O_3–Th–Cu hollow cathode filled with argon and traces of deuterium. All the recorded bands, lying in the visible region, belong to six electronic transitions towards the $X^1\Sigma^+$ fundamental state of the molecule. Molecular constants and symmetry properties of these states were deduced from the vibrational and rotational analyses. The electronic isotope shift has been obtained from data of the H → X system. Finally, the anomalous intensities observed in the $\Delta v = 2$ sequences of the E → X and G → X systems are explained in terms of a mutual interaction between pairs of vibrational levels belonging to the E and G states. (auth)

1254 TRANSFORMATION OF NEODYMIUM-LASER EMISSION INTO LUMINESCENCE OF Tb^{3+} IN GLASSES COACTIVATED BY Tb^{3+} AND Yb^{3+} IONS. Antipenko, B.M.; Dmitryuk, A.V.; Karapetyan, G.O.; Zubkova, V.S.; Kosyakov, V.I.; Mak, A.A.; Mikhailova, N.V. Opt. Spectrosc. (USSR) 35: No. 3, 315-317 (Sept 1973).

Cooperative sensitization of the luminescence of Tb^{3+} ions by Yb^{3+} in glasses excited by neodymium laser emission was investigated. The quantum yield of the cooperative sensitization process and its dependence on the intensity of the exciting radiation, the composition of the glass, the coactivator concentration, and the temperature were measured. (auth)

1255 INTERPRETATION OF LUMINESCENCE SPECTRA OF URANYL MOLYBDATE AND URANYL TUNGSTATE. Zolin, V.F.; Rozman, S.P.; Fisher, P.S. Opt. Spectrosc. (USSR) 35: No. 3, 345-346 (Sept 1973).

The fluorescence spectra of uranyl molybdate and uranyl tungstate were studied. The frequencies of the 0-0 transition and the vibrations associated with this transition are given. Vibrational assignment and intensity of vibrational bands are also given. (AIP)

1256 INFLUENCE OF ELECTRON CORRELATION ON GENERALIZED OSCILLATOR STRENGTHS FOR He. Banyard, K. E.; Seddon, G. J. (Univ. of Leicester, Eng.). J. Phys., B (London); 7: No. 4, 429-439(11 Mar 1974).

The influence of electron correlation in the determination of generalized oscillator strengths f(K), where K is a change of momentum, is examined in detail for He. The excitation transitions considered are $1^1S \rightarrow 2^1P$ and $1^1S \rightarrow 3^1P$. Electron correlation is introduced into the description of the 1^1S ground state in a systematic way by using the natural expansion of a configuration-interaction (CI) wave function developed by Weiss (Phys. Rev. 122: 1826-36 (1961)). By truncating this expansion to the first X terms and renormalizing a series of wave functions is obtained ranging from a Hartree-Fock equivalent (X = 1) to the full CI function (X = 15). Operating within the first Born approximation, three standard formulations for evaluating f(K) are used and their sensitivity with respect to correlation effects is discussed, and a comparison of the present results is made with those of other workers. Although the inclusion of the first correlation configuration in the 1^1S wave function did not necessarily guarantee an improvement in f(K), the introduction of the second correlation term in the natural expansion gave rise to a significant improvement in f(K) for all K regardless of the mode of calculation. As X = 1 → 15, the trends in the behavior of f(K) for each excitation transition were very much alike. The cause of such similarity is analyzed and discussed. In addition, it is noted that the use of the total CI wave function of Weiss to describe the He(1^1S) state gives better f(K) values, for each excitation, than the use of an explicitly correlated wave function of comparable energy. (auth)

1257 CHEMICAL SHIFTS OF X RAY ENERGIES. Coulthard, M. A. (Monash Univ., Clayton, Australia). J. Phys., B (London); 7: No. 4, 440-450(11 Mar 1974).

Free ion relativistic Hartree-Fock results were used to calculate energies and chemical shifts of K and L x rays in Mo, Sn and some rare earths. Agreement with experimental chemical shifts in Sm and Eu is good. When exchange is treated fully, the relative magnitude of the K_{β_1} and K_{β_3} shifts between di- and tri-valent rare earth ions is shown to depend strongly on whether the electron involved in the change of valence state is from the 4f- or $4f^n$ group. Further experimental checks on this prediction are suggested. The method is compared with Moessbauer isomer shifts as a means of deducing the electron configuration of crystal chemical bonds. (auth)

1258 SUM RULES FOR ELECTRIC QUADRUPOLE TRANSITIONS. Rosenthal, D.; McEachran, R. P.; Cohen, M. (York Univ., Toronto). Proc. Roy. Soc. (London), Ser. A; 337: No. 1610, 365-378(26 Mar 1974).

Sum rules for matrix elements occurring in calculations of electric quadrupole radiation were derived and tested for the helium and sodium isoelectronic sequences, using frozen-core atomic wave functions. Electric quadrupole polarizabilities were calculated for the metastable 2^1S and 2^3S states of He, Li^+, Be^{2+} and B^{3+} and for the 3^3S states of Na, Mg^+ and Al^{2+}. The results serve to confirm the reliability of these wave functions for calculating one-electron atomic properties. (auth)

1259 CHEMICAL EFFECTS ON ELECTRON BINDING ENERGIES IN YTTRIUM BY THE X-RAY METHOD. Singh, V. B.; Agarwal, B. K. (Allahabad Univ., India). J. Phys., C (London); 7: No. 4, 831-840(21 Feb 1974).

The position of the x-ray K-absorption edge of yttrium metal was measured for the first time. The chemical shifts of the K-absorption edge and fluorescence $K_{\alpha 1,2}$ lines of yttrium were studied and discussed in terms of covalency and core electron binding energy. The fine structure on the high energy side of the main edge shows similar features for the Y^{3+} ion in dilute aqueous solutions and in solid ionic compounds, showing that the fine structure is essentially determined by transitions into bound states of the K-excited atom. Bond lengths for compounds were calculated from the maxima-minima separations in the observed fine structures. (auth)

1260 MIRROR SYMMETRY IN SPECTRA AND PROPERTIES OF EXCITED STATES OF URANYL COMPLEXES. Kopashova, I.M.; Larkin, G.N.; Umreiko, D.S. Opt. Spectrosc. (USSR) 35: No. 2, 143-146 (Aug 1973).

The mirror symmetry of the electronic-vibrational spectra of uranyl nitrate and chloride compounds at low temperatures was analyzed. A close analogy between the structure of the luminescence and absorption bands was established for nitrates, which permitted us to draw conclusions on the qualitatively identical mechanism of interaction of the electronic and vibrational motion in the various states. A substantial perturbation of the usual interrelationships between the atoms in the complexes during optical excitation was detected in chlorides, which is due to the high degree of correlation of their electron shells. The process of light absorption is accompanied by a change in the degree of covalency of the coordination interaction between the central uranium atom and its surrounding ligands and the externally spherical cations. The decrease in their vibrational frequencies in the upper states is considered to be a result of the decrease in the acceptor capabilities of uranium during excitation of the complex. (auth)

1261 POPULATION INVERSION DURING ABSORPTION SATURATION BY ROTATIONAL-VIBRATIONAL TRANSITIONS OF MOLECULES. Golger, A. L.; Letokhov, V. A. Kvantovaya Elektron. (Moscow); No. 1, 30-40(1973). (In Russian).

A theoretical examination is made of the possibility of producing population inversion in absorption saturation of the fundamental oscillation by optical resonance pumping for the case in which equilibrium is maintained with respect to the rotational sublevels of molecules. It is shown that pumping in a single line alone produces emission with relatively low energy loss (by the magnitude of a rotational quantum) on a large number of rotational-vibrational lines. The coefficient of absorption (gain) in P-, Q- and R-lines is considered as a function of the species and number of the line which is resonant with pumping and of the value of the rotational gas constant. As an example, the coefficient of amplification (absorption) of gaseous HF is calculated by the $1 \rightarrow 0$ transition of the HF molecule with pumping in the P-line. It is shown that at 300°Kelvin and a pressure of 10 mm Hg for HF and 200 mm Hg for the buffer gas, pumping in line P(0) in HF can give a coefficient of amplification on the order of 0.5 cm^{-1}. Bibliography of 12 titles. (Referativnyi Zh.)

1262 APPROXIMATE EVALUATION OF THE POPULATION OF ELECTRON SHELLS OF ATOMS AND THEIR IONIZATION AT HIGH PRESSURE IN THE STATISTICAL THOMAS–FERMI MODEL Shul'man, G. A.; Papou, N. E. (Brest State Pedagogical Inst., USSR). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 86-89(1974). (In Russian).

A calculation was made of the population of the electron shell of Ni atoms at pressures which correspond to their ideal population. It was shown that at this pressure, energetically very advantageous, there exists singly ionized Ni atoms. This led to the conclusion that even before the appearance of ideal population of the electron shell under the effects of high pressure its ionization begins. Calculations made were done in the framework of the statistical model of the atom by means of the direct variational method. (tr-auth)

1263 VARIATIONAL PROBLEMS RELATED TO THOSE WHICH LEAD TO THE SCHROEDINGER EQUATION OF HELIUM-LIKE ATOMS. Makai, E. (Mathematical Inst., Budapest). Stud. Sci. Math. Hung.; 8: No. 1-2, 133-140(1973).

A study is made of variational problems related to those leading to the Schroedinger equation of helium-like atoms in which it is shown that if the values of certain determinants given later do not vanish and if there exist stationary functions to the modified variational problem, then every stationary function is of the form $1 - Zs + \frac{1}{2}u + 0(s^2)$ in the neighborhood of $s = 0$, apart from a constant factor. This result supports the likelihood of the hypotheses concerning the ground state of the helium atom. (JFP)

1264 HIGH RESOLUTION STUDIES OF ELECTRON EXCITATION. III. Polarization Near Threshold of Light From the 4D States of Helium. Heddle, D. W. O.; Keesing, R. G. W.; Watkins, R. D. (York Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 337: No. 1610, 443-450(26 Mar 1974).

The polarization of the helium lines at 492.2 nm ($4^1D - 2^1P$) and 447.2 nm ($4^3D - 2^3P$) was measured over an energy range of about 0.8 eV above threshold using velocity selected electrons. The measurements are free from the effects of instrumental polarization. In both cases it is found that the value of the polarization at the lowest energies for which a signal can be detected is quite consistent with the threshold value predicted by conservation of angular momentum. At higher energies it is found that the polarization falls rapidly. It is suggested that this rapid fall is a consequence of a $1s\,4d^2\,{}^2S$ resonance just below the threshold. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

1265 ELECTRIC FIELD AND TEMPERATURE DEPENDENCE OF POSITRON ANNIHILATION IN ARGON GAS. Lee, G. F.; Jones, G. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 52: No. 1, 17-28(1 Jan 1974).

The annihilation rate of positrons in argon gas was measured over the temperature range of 135 to 573 K with applied d.c. electric fields per unit gas density up to 35 V cm^{-1} $amagat^{-1}$. An analysis of these data was carried out assuming that the annihilation rate and the momentum-transfer rate can both be approximated by functions of the form Av^B over this velocity range. Results of the analysis indicate a strong velocity dependence for both the annihilation rate and the momentum-transfer rate. For velocities in atomic units ($e^2/\hbar$), the annihilation rate could be represented by $\nu_a(v)/D = (1.195 \times 10^6)\, v^{-0.480}\ s^{-1}\ amagat^{-1}$ over the velocity range: 0.03 to 0.065 $e^2/\hbar$. The momentum-transfer rate was similarly determined as $\nu_d(v)/D = (2.11 \times 10^{11})\, v^{-0.49}\ s^{-1}\ amagat^{-1}$. The statistical errors in these results are velocity dependent, with the largest being 16%. A modified effective range parameterization of the momentum-transfer cross section gives a zeroth-order scattering length of $A_0 = (-4.4 \pm 0.5)\ a_0$ for positron-argon collisions. No evidence of a velocity dependence in the orthopositronium quenching rate at room temperature was detected. (auth)

1266 REACTIVITY OF POSITRONIUM ATOMS TOWARD SOME COBALT(III) COMPLEXES IN AQUEOUS SOLUTIONS. Bartal, L. J.; Ache, H. J. (Virginia Polytechnic Inst., Blacksburg). J. Inorg. Nucl. Chem.; 36: No. 2, 267-272(Feb 1974).

The reactions of thermal positronium atoms were studied with a variety of cobalt(III) complexes in aqueous solutions, and the rate constants for these processes determined. The rate constants for the interaction of the complex ions $[Co(III)(NH_3)_5X]$ where X = NH_3, OH^-, H_2O, NO_3^-, F^-, Cl^-, Br^-, 0Ac, o-phthalate and p-phthalate with Ps were found to be k_{solute} = 2.65, 2.74, 5.90, 5.37, 1.94, 15.7, 31.5, 5.35, 2.56 and 4.53×10^9 l/mole sec, respectively. The rate constant for the reaction of $[Co(CN)_6]^{3-}$ with Ps-atom is considerably smaller; $k_{solute} = 0.18 \times 10^9$ l/mole sec. The data are discussed in terms of modern theories of electron transfer mechanisms. (auth)

1267 USE OF POSITRONS FOR THE STUDY OF SOLIDS. Dekhtyar, I. Ya. (Inst. of Metaphysics, Kiev). Phys. Rep.; 9C: No. 5, 243-353(Mar 1974).

In this review the present state of the use of positron annihilation for the study of solids is considered. The possibilities of using the positrons for studying the properties of, and investigating of processes in, both the body and the surface of real solids, are discussed. (auth)

Collision Phenomena

Refer also to abstracts 1239, 1264, 1776, and 2262.

1268 (BUP-58) UNIVERSAL CROSS SECTIONS FOR K, L, AND M SHELL COULOMB IONIZATION BY PROTON IMPACT (A NUMERICAL GUIDE). Kocbach, L. (Bergen Univ. (Norway). Dept. of Physics). Nov 1973. 23p. Dep. NTIS (U. S. Sales Only) $4.25.

Universal cross sections for K-, L-, and M-shell Coulomb ionization by protons were computed on the basis of the straight line version of the SCA model. The theoretical basis for the calculations is briefly described and a numerical example given. The computed results are presented in tables for silver and gold, and the cross section functions presented graphically. (JIW)

1269 (BUP-61) COULOMB IONIZATION OF THE L SUB-SHELLS BY HEAVY CHARGED PROJECTILES. Hansteen, J. M.; Johnsen, O. M.; Kocbach, L. (Bergen Univ. (Norway). Dept. of Physics). Mar 1974. 11p. Dep. NTIS (U. S. Sales Only) $4.00.

Some features of the Coulomb ionization probabilities for the L sub-shells of a heavy target atom are investigated by use of the semi-classical (SCA) model in impact parameter form. Based on hydrogen-like target electron wave functions, a few predictions on energy and impact parameter variations for individual sub-shells are given. (auth)

1270 (CONF-721231-PA, pp 27-48) ATOMIC COLLISIONS AND BEAM FOIL SPECTROSCOPY. Sood, D. K. (Bhabha Atomic Research Centre, Trombay, India). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

Low-energy accelerators have been used to study violent heavy ion–atom collisions, in which multiple inner-shell vacancies are produced. Study of such vacancies by characteristic x-ray emission is discussed. Experimental and theoretical excitation functions for K, L, and M shells are shown. The problem of "united atom" x rays is considered, and energy levels of molecular orbitals for the Ar–Ar system and molecular orbital energy-level diagrams for collisions of Ar with B, C, Al, and Ca are given. It is concluded that the observed spectra come from the united Ar–Ar system, formed from the interaction of incident ions with ions which have become implanted. Applications of this work can be made to elemental trace analysis, a practical x-ray amplifier, and a possible x-ray laser. Beam–foil spectroscopy is taken up in the latter part of the paper. Its uses and a typical experimental set-up are described; in particular, the aspects of charge separation and lifetime measurements are discussed. (16 figures) (RWR)

1271 (IAE-2256) CONCERNING THE EFFECT OF ATOMIC COLLISIONS ON THE CHARACTERIZATION OF LAMB FAILURE. Vdovin, Yu. A.; Galitskii, V. M.; Gurevich, A. I.; Ermachenko, V. M.; Satarov, L. M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1973. 20p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

The effect of elastic collision on the form of the Lamb failure was examined. A computer numerical calculation for He–Ne lasers with wave length of 0.63 μm was carried out for comparison with experimental values. (tr-auth)

1272 MEASUREMENT OF QUANTITIES RELATED TO THE CHARGE AND MOMENTUM DENSITIES OF ATOMS AND MOLECULES BY USE OF keV ELECTRON SCATTERING. Bonham, R. A.; Wellenstein, H. F. (Indiana Univ., Bloomington). Int. J. Quant. Chem., Symp.; No. 7, 377-394(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

Experiments utilizing keV incident electrons scattered from atomic and molecular targets are described. The scattered electron intensity as a function of both scattered angle and energy lost by the incident electron upon collision with the target is recorded. Data of this type collected over a grid of both angle and energy loss values define a surface which contains extensive information concerning the electronic structure of the target system. The various regions of interest on this surface and their relation to charge and momentum density are described within the framework of the first Born approximation. The theory is compared to recently collected data on atomic helium and molecular hydrogen. (auth)

1273 PRACTICAL INVERSION PROBLEM IN MOLECULAR BEAM SCATTERING. Sheen, S.; Marchessault, R.; Mueller, C. R.; Anderson, T. (Purdue Univ., Lafayette, IN). Int. J. Quant. Chem., Symp.; No. 7, 40-419(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

The present status of the inversion of molecular scattering data is reviewed with particular emphasis on the importance of the rapid quantal undulations. It is concluded that the semiclassical approximation may provide valuable guidelines for localized distortions in the phase-shift curve, but that the full quantum treatment is required for quantitative accuracy. The extension of the inversion techniques to the two-potential problem is also briefly discussed. (auth)

1274 CHARGE TRANSFER BETWEEN O^- IONS AND O_2 MOLECULES IN THE GROUND STATE AND SINGLET DELTA EXCITED STATE. Mathis, R. F. Rolla, MO; Univ. of Missouri (1973). 73p. University Microfilms Order No. 74-4355.

Thesis (Ph.D.).

A cross-beam apparatus was built and used to study charge transfer between O^- ions and O_2 molecules in the ground state and in the metastable, singlet delta, excited state. The energy of the incident ions ranged from 10 to 10,000 eV. The cross section for charge transfer between O^- and ground state O_2 was found to peak at about 5 keV, as predicted on the basis of the Rapp and Francis theory. At the lower energies there is good agreement with the previous measurements of Snow, et al., and Rutherford and Turner, who also used crossed beam techniques. The cross section for charge transfer between O^- and metastable excited $O_2(^1\Delta_g)$ was found to be small over the energy range of 40 to 10,000 eV. There are no other experimental measurements for comparison. (Diss. Abstr. Int., B)

1275 VELOCITY-DEPENDENCE OF THE TOTAL ELASTIC SCATTERING CROSS SECTION FOR Ne–Kr AND Ne–Xe COLLISIONS. Robertson, W. R. Charlottesville, VA; Univ. of Virginia (1973). 85p. University Microfilms Order No. 73-31,156.

Thesis (Ph.D.).

Velocity-dependent absolute cross sections were measured for the elastic scattering of the neutral inert gas systems Ne–Kr and Ne–Xe. Data reported at sixteen discrete relative velocities over the range from 600 to 1750 meters per second was obtained utilizing a supersonic neon beam in conjunction with a cooled scattering cell. The first two extrema of the quantum undulation pattern were clearly resolved in both systems and used to analyze the data assuming an LJ(12,6) potential. A Buckingham–Corner, BC(6,8), potential was also investigated. The LJ(12,6) potential could not adequately describe the intermolecular potential for either system, yielding effective cross sections too high at the low velocity end and too low at the high velocity end. The Buckingham–Corner potential, however, was able to provide very good fits to the experimental cross section results. Results from a best fit BC(6,8) potential to the experimental data include: For Ne–Kr, $C^{(6)}$ = 28.5 a.u., $C^{(8)}/C^{(6)}$ = 15.2 a.u., $\epsilon = 9.35 \times 10^{-15}$ erg, $r_m = 3.42 \times 10^{-8}$ cm, and reduced curvature $\kappa = 53.1$. For Ne–Xe, $C^{(6)}$ = 41.7 a.u., $C^{(8)}/C^{(6)}$ = 23.6 a.u., $\epsilon = 9.0 \times 10^{-15}$ erg, $r_m = 3.67 \times 10^{-8}$ cm, and $\kappa = 50.2$. In addition, the van der Waals coefficients for both systems are in very good agreement with reported theoretical values. (Diss. Abstr. Int., B)

1276 VELOCITY-DEPENDENCE OF THE TOTAL ELASTIC SCATTERING CROSS SECTION FOR NEON–NEON AND NEON–ARGON COLLISIONS. Shinn, J. L. S. S. Charlottesville, VA; Univ. of Virginia (1973). 67p. University Microfilms Order No. 73-31,163.

Thesis (Ph.D.).

Total effective cross sections were measured for the elastic scattering of Ne from Ne and Ar, separately, at sixteen discrete relative velocities using a nozzle beam-scattering cell system. For the Ne–Ne system, the relative velocities range from 639 m/sec to 1759 m/sec. For the Ne–Ar system, they range from 609 m/sec to 1749 m/sec. The neon beam was "seeded" with various concentrations of helium or argon to produce the desired range of relative velocities. The scattering gas, neon or argon, was cooled to near liquid nitrogen temperature to reduce the spread in the relative velocity distribution. The observed relative velocity-dependence of the total cross section was found to exhibit the undulatory behavior predicted by quantum mechanical analysis. Using several assumed potential forms, theoretical predictions of this dependence were obtained using the JWKB approximation and the knowledge of the relative velocity distribution. For both systems observed, Lennard–Jones potentials were found to be poor models. For Ne–Ne, the agreement of ϵ and r_m was good with both the MSV potential proposed by Lee et al, and the No. 5 potential of Morse-6 Hybrid proposed by Konowalow. The small disagreement of the attractive force constants suggests a higher C_6 value of 6.83 atomic units and a higher C_8 value than proposed by Lee et al. For Ne–Ar, the general shape of the Q_{Eff} vs g curve calculated from the No. 5 potential of Morse-6 Hybrid proposed by Konowalow and that determined experimentally were found in good agreement. However, the absolute values of Q_{Eff} were not predicted very well. A "modified" Morse-6 Hybrid potential with the same ϵ value of 9.677×10^{-15} erg and r_m value of 3.48 Å but with C_6 = 22.6 atomic units and C_8 = 182.0 atomic units, is suggested. (Diss. Abstr. Int., B)

1277 TRAJECTORIES IN ION–MOLECULE REACTIONS. Tully, J. C. (Bell Telephone Labs., Inc., Murray Hill, NJ). Ber. Bunsenges. Phys. Chem.; 77: No. 8, 557-565(Aug 1973).

An appraisal of the classical trajectory method as a tool for studying ion-molecule reactions is presented. The method has recently been extended to incorporate nonadiabatic processes such as charge transfer. This approach has been applied to two fundamental ion-molecule reactions, $Ar^+ + H_2$ and $H^+ + H_2$ (and isotopic variants). Important conclusions concerning the dynamics of these reactions are discussed. Detailed comparisons with the results of molecular beam experiments are included. The agreement between the computer simulations and experiment is indicative of a very promising future for the trajectory method. Provided that reliable potential energy surfaces can be constructed, the method should be capable of accurate prediction of most reaction attributes, e.g. reaction rates, product internal energy distributions, etc. In addition, it can provide unambiguous information about reaction mechanism that cannot be obtained by experimental means, and it can be used to assess the validity of models which employ simplified forces or dynamics. Possible directions are suggested for future work in this area. (GE)

1278 DIFFERENTIAL CROSS SECTIONS FOR THE ELASTIC SCATTERING OF ELECTRONS FROM ATOMIC HYDROGEN AT LOW ENERGIES. Williams, J. F. (Queen's Univ., Belfast). J. Phys., B (London); 7: No. 3, L56-L60(21 Feb 1974).

Absolute values of the angular differential cross sections for the elastic scattering of electrons from atomic hydrogen were measured for incident electron energies of 3.4 eV and 8.7 eV and over the angular range of 30 to 150 degrees. The experimental method was based upon the standard crossed electron, modulated atom beam method with high resolution (0.07 eV) energy analysis of the incident and scattered electrons. The accuracy of the present measurements is ±6% which permits distinctions to be made between the various theoretical approximations. It is shown that the variational calculated values and the pseudo-state close coupling approximation values (Burke et al., J. Phys. B. Atom. Molec. Phys.; 2: 1142-54 (1969)) are in good agreement with measured values over the complete angular and energy range. The three-state close coupling and one-state static exchange approximation values agree with experimental values only at 8.7 eV for scattering angles greater than 90°. (auth)

1279 CALCULATION OF FLUORESCENCE X-RADIATION PRODUCTION. Casnati, E.; Fioratti, M. P.; Piermattei, S. R. (CNEN Cassacia, Italy). Minerva Fisiconucl.; 16: No. 3, 113-130 (1972). (In Italian). (RT/PROT-(73)18).

A calculation method is described for evaluating the exposure rate due to the fluorescence x-rays excited in targets of different elements by bremsstrahlung radiation produced by commercial x-ray apparatus. The contribution of Compton and Rayleigh radiation produced by scattering of the primary beam inside the target is also evaluated. The influence on the fluorescence x-rays production of the following parameters: atomic number of the target, target thickness, voltage applied to x-ray tube, was analyzed. Such an analysis enables the choice of the best condition for producing almost monochromatic beams with scarce contamination of continuous radiation. (auth)

1280 GLORY STRUCTURE IN THE ANISOTROPY OF THE TOTAL COLLISION CROSS SECTION. Schwartz, H. L.; Stolte, S.; Reuss, J. (Univ. of Nijmegen, Netherlands). Chem. Phys. (Amsterdam); 2: No. 1, 1-5(Sep 1973).

Measurements of glory structure in the orientational anisotropy of the total collision cross section are reported. Using a beam of NO molecules in the $^2\Pi_{\frac{1}{2}}$-state the systems NO–Ar, Kr and Xe were investigated at relative velocities between 450 and 700 m/sec, corresponding to approximately one half of a glory wavelength for all systems. Values of the anisotropy parameters $q_{2,6}$ and $q_{2,12}/q_{2,6}$ are presented. (auth)

1281 QUANTUM MECHANICAL INTERPRETATION AND ANALYSIS OF THE INTERACTION OF TWO NEUTRAL HELIUM ATOMS. Prasad, N. (Kisan Coll., Nalanda, India). Indian J. Pure Appl. Phys.; 11: No. 8, 541-544(Aug 1973).

The quantum mechanical formula for the interaction of two neutral helium atoms was modified to be in the Buckingham potential form. By applying the method of least squares fit near the minimum potential energy of the system, the values of the different constants in the modified expression were evaluated. These values of the constants compare well with the values obtained independently using Pitzer's empirical formula. (auth)

1282 THICK TARGET YIELDS OF K, L, AND M X-RAYS BY FAST HEAVY ION BOMBARDMENTS. Shima, K. (Hiroshima Inst. of Tech., Itsukaichi, Japan); Takasaki, M.; Sakai, S.; Terashima, Y. Jap. J. Appl. Phys.; 12: No. 11, 1663-1669(Nov 1973).

Thick target yields of characteristic x-rays were measured by various heavy ion bombardments. The various combinations of x-rays, target elements, incident particles and their energy ranges are given as follows: Mg-K, Al-K, Ti-K, Ni-L, Cu-L, Mo-L, Ag-L, Cd-L, Sn-L, Ta-M, W-M, Pt-M, Au-M and Pb-M x-rays for C^+ (0.9–3.1 MeV), N^+ (0.9–2.9 MeV) and O^+ (0.9–2.5 MeV) bombardments, and Mg-K x-rays for Ne^{3+} (0.7–5.0 MeV) and Ar^{3+} (0.6–4.0 MeV) bombardments. Measurements were made by the conventional thick target method and x-rays were detected by a proportional counter. Results have systematic dependence on the atomic number of incident particles and target materials. The yield curve of Mg-K x-rays by the Ar^{3+} bombardment was found to have a different behavior from those curves obtained by other heavy ion bombardments. (auth)

1283 ELASTIC SCATTERING OF HIGH ENERGY ION BEAMS. II. Repulsive Potentials Between K^+-Ions and Hydrogen Molecules. Kita, S. (Tohoku Univ., Sendai). Tohoku Daigaku Kagaku Keisoku Kenkyusho Hokoku; 22: No. 1, 13-38(Dec 1973). (In Japanese).

Integral collision cross sections were measured for potassium ions with energies between 500 and 4000 eV scattered by room temperature H_2 and D_2 molecules. The cross sections of the two systems (K^+-H_2 and K^+-D_2) are different about 1.5%. This difference is caused by the fact that the kinetic energies in the center of mass frame corresponding to the same kinetic energy in the laboratory frame are different for the two collision systems. Spherical repulsive potentials determined from the measured cross sections for these two systems are represented within about 1% by the same expression as follows: K^+-H_2, D_2: $V(r) = 805 \exp(-3.52\ r)$ eV, 1.33 Å < r < 1.99 Å. Nearly head-on collision cross sections calculated with this potential function for these two systems were negligibly small compared with the measured cross sections. (auth)

1284 IONIZATION OF ATOMIC HYDROGEN BY AN INCIDENT ELECTRON IN A PSEUDO-STATE APPROXIMATION. Gallaher, D. F. (Univ. of Western Ontario, London). J. Phys., B (London); 7: No. 3, 362-370(21 Feb 1974).

The electron-hydrogen ionization cross section was calculated in a 1s 2s 2p pseudo-state approximation at impact energies of 20.4, 27.2, 54.4 and 81.6 eV. Excellent agreement is attained with the experimental curve of Fite and Brackmann (Phys. Rev.; 112: 1141-1151(1958)) at impact energies up to 27.2 eV while above 27.2 eV the pseudo-state curve falls monotonically with increasing impact energy from their experimental curve. Comparison is also made up to 23 eV impact energy with the more recent experimental result of McGowan and Clarke (Phys. Rev.; 167: 43-51(1968)) where detailed agreement is not so good. (auth)

1285 PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS. Invited Lectures and Progress Reports. VIII ICPEAC, Belgrade, Yugoslavia, July 16–20, 1973. Cobic, B. C.; Kurepa, M. V. (eds.). Belgrade; Institute of Physics (1973). 728p. (CONF-730709-).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973).

There were 37 lectures one of which was abstracted previously in NSA. For an abstract of this paper see abstract number 28: 23927. Separate abstracts were prepared for 29 papers. (JFP)

For abstracts of individual lectures see: 1286–1314.

1286 INELASTIC PROCESSES IN ATOMIC COLLISIONS AT MEDIUM ENERGIES. Afrosimov, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). pp 3-25 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A review is given of the work of Prof. N. V. Fedorenko on fundamental processes, scattering, and inelastic energy losses in atomic collisions. Fundamental processes involving change of state, the scattering of atomic particles, and inelastic energy losses are covered. (JFP)

1287 CERTAIN PROBLEMS IN THE HEAVY PARTICLE COLLISIONS. Demkov, Yu. N. (Leningrad State Univ.). pp 26-41 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

Those aspects of heavy particle collisions are considered which are from theoretical point of view of general interest. All the considered problems can be solved analytically in a closed form within some assumptions, and most of the results presented in this review were obtained recently by the theoretical group of Leningrad State University. (auth)

1288 EXCITATION AND IONIZATION IN ION–ATOM COLLISIONS (EXPERIMENTAL ASPECTS). Barat, M. (Paris Univ., Orsay, France). pp 43-70 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The review is restricted to excitation processes including ionization during heavy particle collisions in the moderate energy range from ten eV up to a few keV for which the quasi-molecular treatment of the collision remains valid for outer-shell excitation. Experimental techniques, cross sections, and some specific cases are included. (JFP)

1289 EXCITATION AND IONIZATION IN ION–ATOM COLLISIONS (THEORETICAL ASPECTS). McCarroll, R. (Univ., Bordeaux). pp 71-95 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

Ion–atom and atom–atom collisions in the energy range $\Delta E \ll E \ll \frac{1}{2}\mu v_0^2$, where ΔE is the excitation (de-excitation) energy, μ is the reduced mass of the colliding system, and v_0 is the velocity in a classical Bohr orbit of the electron involved in the collision, are considered. $H^+ + H$, $He^+ + He$, $Li^+ + He$, and He + He systems including their differential cross sections are considered. (JFP)

1290 INNER-SHELL IONIZATION BY HEAVY IONS IN THE MeV ENERGY RANGE. Burch, D. (Univ. of Washington, Seattle). pp 97-115 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A survey is made of recent work on inner-shell ionization by heavy ions with $Z_1 > 4$ at collision energies of 5 to 100 MeV. Current data are from Van de Graaff, cyclotron, and HILAC facilities and include: high resolution x-ray and Auger-electron spectra, vacancy-production cross sections for a wide range of ion-atom systems and energies, the dependence of some of these cross sections on the incident-ion charge state and impact parameter, systematic studies of the multiple ionization which is characteristic of heavy-ion collisions, and measurements of the resultant changes in the fluorescence yields. Ionization mechanisms, united-atom phenomena, and the effects of nuclear Coulomb excitation are discussed. (auth)

1291 ELECTRON AND X-RAY PRODUCTION IN ION–ATOM COLLISIONS. Stolterfoht, N. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 117-136 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

Recent progress in experimental studies of x-ray and electron emission following atomic inner-shell excitation by fast charged particles is reviewed. Mainly measurements under single collision conditions at impact energies of several hundred keV are chosen for consideration. Cross sections for inner-shell ionization are discussed in terms of two limiting processes: Binary ion-electron collisions at high velocities, and excitation via electron promotion in slow ion-atom collisions. For light ion impact, emphasis is given to recent investigations of outer-shell excitation in addition to inner-shell vacancy production, as analyzed from the intensity of satellite lines in the emission spectra. Cross sections for x-ray and Auger-electron production are compared for a study of multiple ionization effects on the fluorescence yield. For heavy ion impact, measurements of Auger-electron emission from both the projectile and the target are discussed. Primarily asymmetric collisions are reviewed allowing for an extended application of the Fano–Lichten model. (auth)

1292 COINCIDENCE STUDIES BETWEEN PHOTONS AND SCATTERED PARTICLES. Jaecks, D. H. (Univ. of Nebraska, Lincoln). pp 137-157 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The general method of photon-particle coincidence studies is presented as a tool for investigating the parameters of inelastic collisions. Experimental results for inelastic, differential cross sections and total cross sections are presented for various systems. These data are interpreted wherever possible, in terms of collision models. Results of lifetime measurements and inner shell excitation, with subsequent x-ray emission are not discussed. (auth)

1293 METASTABLE NEGATIVE IONS AND THEIR FORMATION IN ATOMIC COLLISIONS. Il'in, R. N. (Ioffe Inst. of Physics and Tech., Leningrad). pp 159-168 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The study of excited metastable negative ions and processes responsible for their formation by means of the photodetachment method and the method of ionization by electric field is discussed. Various cross sections are presented. (JFP)

1294 CORRELATION EFFECTS IN COLLISION PROCESSES. Amusia, M. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). pp 171-204 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The random phase approximation is used to prove the limited nature of the single-electron approximation by revealing substantial manifestations of the many-electron correlations. Photoabsorption at low and medium energies including correlations in the random phase approximation with exchange, electron scattering from atoms and the effect of many-electron correlations, and other manifestations of many-electron correlations are treated. (JFP)

1295 CORRELATIONS IN He^{**}, e + He, AND RELATED SYSTEMS. Fano, U.; Lin, C. D. (Univ. of Chicago). pp 229-237 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The identification of eigenvariables in atomic correlation problems is stressed for the study of correlations in He^{**}, e + He, and related systems. The Marek approach for He^{**} is developed more explicitly, and coincidence experiments on $e + He \rightarrow He^+ + 2e$ are discussed in which it is pointed out that deep minima are observed in the angular distributions of the collision products. (JFP)

1296 PHOTOIONIZATION AND ELECTRON SCATTERING CROSS SECTIONS CALCULATED BY MANY BODY PERTURBATION THEORY. Kelly, H. P. (Univ. of Virginia, Charlottesville). pp 239-251 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

Many-body perturbation theory was applied to calculate the photoionization cross sections for atoms and molecules. The elastic scattering of electrons by argon atoms is also discussed. The results for argon, zinc, and helium are discussed. (JFP)

1297 CORRELATION EFFECTS IN ELECTRON SCATTERING BY POSITIVE IONS. Seaton, M. J. (University Coll., London). pp 253-262 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

Correlation effects for a many-electron system are defined to be due to the difference between a central-field calculation and the exact definition. The electron-impact transitions in O^{2+} are considered. (JFP)

1298 EIKONAL THEORY FOR ELECTRONIC TRANSITIONS IN ATOMIC COLLISIONS. Chen, J. C. Y. (Univ. of California, San Diego, La Jolla). Contract AT(04-3)-34. pp 265-295 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

After a brief discussion on the eikonal approximation for potential scattering, the generalization of the eikonal approximation to many-channel problems is considered. There are two alternative ways in which the eikonal approximation for potential scattering was successfully generalized to many-channel problems: namely, the Glauber-eikonal approximation and the coupled-equation eikonal approximation. Progress in the use of the two multichannel eikonal approximations in atomic collision is reviewed. (auth)

1299 APPLICATION OF COMPLEX ANGULAR MOMENTUM METHODS TO ATOMIC SCATTERING PROBLEMS. Doverspike, L. D. (Coll. of William and Mary, Williamsburg, VA). pp 297-309 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A review is given of recent work on the practical application of Regge pole theory to the analysis of low energy ion–atom elastic differential scattering. The basic ideas involved in the Remler–Regge method are discussed, and it is shown how they may be used in the analysis of particular ion–atom scattering experiments. (JFP)

1300 ATOM IN THE STRONG ELECTROMAGNETIC FIELD. Delone, N. B. (Lebedev Inst. of Physics, Moscow). pp 313-338 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The discussion of the interaction of an atom with light covers the multi-photon ionization and the tunnel effect in the variable field, limitations of perturbation theory applications to multi-photon processes, multi-photon ionization property dependence on parameters determining the atomic system and the light field, multiphoton ionization process in the absence of resonance, the multi-photon resonance, and strong perturbation of electronic states. (JFP)

1301 RELAXATION PROCESSES OF EXCITED STATES IN HIGH VELOCITY ION–BEAM EXPERIMENTS. Dufay, M. (Univ. Lyon). pp 381-396 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A review is given showing that the level crossing and RF resonance methods are being applied with a beam-foil source and have given results for multicharged ions. The time dependent character of natural decay after impulsive excitation, specific characteristics of the beam-foil excitation, zero field quantum beats, Zeeman splittings, and the Stark effect and RF resonances studied in beam-foil experiments with hydrogenic ions are covered. (JFP)

1302 SCATTERING OF ELECTRONS BY ATOMS AT INTERMEDIATE ENERGIES. Bransden, B. H. (Univ. of Durham, Eng.). pp 399-416 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The review of the ideas behind several of the newer lines of approach for the scattering of electrons by atoms at intermediate energies covers extension of the close-coupling method, the distorted wave approximation, and second Born and related approximations. (JFP)

1303 INELASTIC SCATTERING OF FAST ELECTRONS BY ATOMS AND MOLECULES. van der Wiel, M. J. (FOM-Institut voor Atoom- en Molecuulfysica, Amsterdam). pp 417-442 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

After a few brief remarks on total ionization and excitation cross sections, the development of differential electron scattering experiments are discussed insofar as they have been concerned with a quantitative study of (parts of) the Bethe surface. Further, a short introduction is given to the recent work on secondary electrons ejected by electron impact. Finally, a review is presented of those experiments in which inelastically scattered electrons have been detected in coincidence with one of the products of the excitation process, i.e., secondary electrons, ions or photons. A number of these coincidence studies, by operating at low momentum transfer of the projectile electron, produce optical oscillator strengths and as such are discussed as alternatives to photon impact experiments using electron synchrotron radiation. (auth)

1304 DOUBLE DIFFERENTIAL CROSS SECTION IN ELECTRON–ATOM IONIZING COLLISIONS. Oda, N. (Tokyo Inst. of Tech.). pp 443-463 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The double differential cross sections (ddcs's) for electron-atom ionizing collisions are classified into the two groups, depending upon the types of the ionization processes, that is, the direct ionization and the indirect (resonance) ionization processes. Recent experimental results on the ddcs's for the direct ionization are compared with theoretical calculations with several kinds of approximations, separately, for the lower and for the intermediate and higher energy outgoing electrons. The single differential cross sections (sdcs's) are derived from the experimental ddcs's. The experimental results on the ddcs's for the indirect (resonance) ionization process are described in terms of the energy spectra of the ejected electrons from autoionizing states. Comparisons are made of the ddcs's for the electron and the heavy particle impacts. (auth)

1305 THRESHOLD MEASUREMENTS IN ELECTRON COLLISIONS. Read, F. H. (Univ. of Manchester, Eng.). pp 465-476 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A summary is given of research on cusps in elastic electron–atom scattering, inelastic threshold spectroscopy, and displaced threshold of autoionizing states. (JFP)

1306 POTENTIAL DETERMINATION FROM MEASUREMENTS OF DIFFERENTIAL SCATTERING CROSS SECTION. Buck, U. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). pp 481-501 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The present possibilities of techniques for the measurement of the differential scattering cross section in molecular beam experiments are outlined. Then the methods of deriving potentials from these measurements are discussed. Some important recent results are presented, and extensions to nonspherically symmetric potentials and direction of future work are suggested. (JFP)

1307 SEMICLASSICAL METHODS IN REACTIVE AND NONREACTIVE COLLISIONS. Miller, W. H. (Univ. of California, Berkeley). pp 503-528 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A recently developed semiclassical theory designed primarily for treating molecular collisions which take place on one electronically adiabatic potential energy surface, i.e., all degrees of freedom internal as well as translation, are heavy particle degrees of freedom, is considered. The general theoretical results are summarized without derivation and illustrated with a few simple examples. Classically forbidden phenomena are given special emphasis. (JFP)

1308 RECENT PROGRESS IN CLOSE COUPLING METHODS FOR ATOM–MOLECULE COLLISIONS. Kouri, D. J. (Univ. of Houston, TX). pp 529-541 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

A review is given of some of the approaches most extensively used recently for close coupling methods for reactive and nonreactive atom–molecule collisions. (JFP)

1309 DIFFERENTIAL INELASTIC SCATTERING OF ATOMIC IONS ON DIATOMIC MOLECULES. Faubel, M. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). pp 543-565 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The experimental methods to study inelastic collisions are reviewed as well as recent studies on the systems H^+-H_2 and Li^+-H_2. (JFP)

1310 ANALYSIS OF MOLECULAR COLLISIONS: AN INFORMATION-THEORETICAL APPROACH. Levine, R. D. (Hebrew Univ., Jerusalem). pp 567-582 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade, Inst. of Physics (1973).

From 8th international conference on the physics of electronic

and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

Before the formulation of a fundamental theory of molecular collisions a diagnostic theory is developed. The optimal means of characterization of the product energy state distribution, compaction of the measured detailed state distributions (or computer simulation thereof), and the development of measures of the specificity of the energy release and of the selectivity of the energy consumption (and their mutual dependence) are considered. (JFP)

1311 QUANTUM SYMMETRY EFFECTS IN THE SCATTERING OF NEUTRAL PARTICLES. Scoles, G. (Univ. of Waterloo, Ont.). pp 583-594 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The review of the present state of research in the field of quantum symmetry effects in the scattering of neutral particles covers low energy elastic scattering, high energy atomic scattering, and reactive molecular scattering. (JFP)

1312 POLARIZED ELECTRONS AND THEIR INTERACTION WITH ATOMS. Drukarev, G. (Leningrad State Univ.). pp 597-620 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The treatment of polarized electrons and their interaction with atoms includes the mathematical description of polarization of the beam, the basic concepts of the theory of interaction of polarized electrons with atoms, and the use of this theory to analyze the information which can be deduced from the experiments with polarized beams. (JFP)

1313 CHEMI-IONIZATION BY DYNAMIC COUPLING. Los, J. (FOM-Institut voor Atoom- en Molecuulfysica, Amsterdam). pp 621-648 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

In this review is discussed the ion pair formation in collisions of alkali atoms and halogen molecules in the eV kinetic energy range. At thermal energies where these collisions are highly reactive, the electron transfer initiates the reaction like a harpoon. Coupling of the ionic and covalent states at points where the diabatic potentials of these states cross is responsible for the mechanism. In the most simple case of an atom-atom collision the process can be understood in terms of a two-state approximation. In fact the behavior at the crossing point ($R_c \simeq 10$ Å) is well described by the Landau–Zener theory. Differential and total cross sections can be calculated semi-classically. This theoretical description is confirmed by an atom-atom (Na–I) scattering experiment; including the proper prediction of the rainbow structure and Stickelberg oscillations. The measurements indicate, however, that also rotational coupling might play a role in the ion pair formation. For the interaction between an atom and a molecule the same mechanism is responsible for chemi-ionization. The picture, however, is much more complicated. The most important features of a molecular target are the angular dependence of the potentials and of the coupling matrix element H_{12}; in the second place the single crossing is replaced by several crossings due to excited states of the reactant and product molecule. Trajectory calculations seem to be the most promising approach in describing these three particle interactions. Total cross section measurements especially reveal the importance of vibrational excitation of the reactant on the one hand, and of excited states in the product molecule on the other. Moreover from these measurements several properties of negative molecular ions can be determined. (auth)

1314 PENNING ELECTRON SPECTROSCOPY. Niehaus, A. (Univ., Freiburg i. B.). pp 649-668 of Physics of Electronic and Atomic Collisions. Cobic, B. C. (ed.). Belgrade; Inst. of Physics (1973).

From 8th international conference on the physics of electronic and atomic collisions; Belgrade, Yugoslavia (16 Jul 1973). See CONF-730709-.

The experimental method of Penning electron spectroscopy (PES) is described. The theoretical description of Penning ionization is then outlined, and examples of experimental evidence—obtained from (PES)—of this description are given. A selection of recent experimental results, apt to point out the different aspects and possibilities of (PES), is then presented and discussed in the frame of the theory. (auth)

1315 CHEMICAL APPLICATION OF MOLECULAR BEAM SCATTERING. Fluendy, M. A. D.; Lawley, K. P. New York; John Wiley and Sons, Inc. (1973). 407p. $24.95.

The topics discussed are classical mechanics of molecular scattering, molecular beam sources, energy and state selection, detection and measurement, quantum mechanics of scattering, and elastic, reactive, and inelastic scattering. (JFP)

1316 MEASUREMENT OF ELASTIC RELATIVE DIFFERENTIAL CROSS SECTIONS FOR ELECTRON HELIUM COLLISIONS AT LOW ENERGIES AND SMALL ANGLES. Arnow, M. M. Cincinnati; Univ. of Cincinnati (1973). 37p. University Microfilms Order No. 74-1676.

Thesis (Ph. D.).

The experiment presented measures the relative differential cross sections in helium for the energies between 1.0 eV and 10.0 eV and at the angles 10, 15, 20, 25, and 30°. The results are compared to the experiments of others and are also compared to the present theories. Since experiments do not overlap very well in this region, conclusions are difficult to draw. It is easier, however, to make comparisons to the theoretical predictions. It is shown that the results of this experiment do not agree well with the theoretical predictions. (Diss. Abstr. Int., B)

1317 DESTRUCTION OF METASTABLE HYDROGEN IN COLLISIONS WITH HELIUM. Dose, V.; Hett, W. (Univ., Wuerzburg, Ger.). J. Phys., B (London); 7: No. 3, L79-L81(21 Feb 1974).

The cross section for collisional destruction of metastable hydrogen by helium was measured for velocities between 4×10^5 and 5×10^6 cm s^{-1}. Cross sections at 43 individual velocities were obtained by an experimental method which combines time-of-flight techniques with a new kind of gas target pressure modulation. Results are compared with the existing rather elaborate theoretical work on the problem as well as with the limited experimental information. (auth)

1318 EXPERIMENTAL TOTAL PHOTOELECTRIC CROSS-SECTIONS. Parthasaradhi. (Andhra Univ., Waltair, India). J. Sci. Ind. Res.; 31: No. 9, 470-476(1972).

A review of the available methods and analysis on the total atomic photo effect cross sections of gamma rays in the energy region 1.0 to 3000 keV is presented. The available experimental cross sections are compared with the available theoretical values. 68 ref. (Indian Sci. Abstr.)

1319 SEMICLASSICAL STUDY OF THE VIBRATIONAL EXCITATION OF H_2 IN COLLISION WITH He. Drake, G. W. F.; Lin, G. S. (Windsor Univ., Ont.). J. Phys., B (London); 7: No. 3, 398-405(21 Feb 1974).

The vibrational excitation and dissociation probabilities of H_2 in a collinear collision with He are calculated, using the semi-classical time-dependent method along with the accurate H_2 molecular potential of Kolos and Wolniewicz (J. Chem. Phys.; 43: 2429 (1965) and 49: 404 (1968)). The complete set of bound and continuum eigenfunctions are represented in terms of a truncated basis set of harmonic oscillator functions. The results differ significantly from the Morse potential quantum mechanical calculations of Clark and Dickinson (J. Phys. B. Atom. Molec. Phys.; 6: 164-80(1973)). In addition, a state-dependent interaction potential is suggested to allow for the different average sizes of the H_2 molecule in its initial and final states. The state dependent potential greatly enhances the transition probabilities to highly excited states and the continuum. (auth)

1320 EFFECTIVE CROSS SECTIONS FOR EXCITATION OF SPECTRAL LINES OI DUE TO COLLISIONS OF ELECTRONS WITH OXYGEN ATOMS AND MOLECULES. Penkin, N.P.; Tsygir, O.D. Opt. Spectrosc. (USSR) 35: No. 3, 348-349 (Sept 1973).

The effective excitation cross section for OI due to electron collisions was measured. The emission spectra from a gas discharge in oxygen were recorded in the 500-900 nm region. From the measured plasma parameters and the known probabilities of the elementary processes in the discharge, the rates of population of the $3p^3P$ and $3p^5P$ states of oxygen were obtained. (AIP)

1321 ELECTRONIC AND IONIC IMPACT PHENOMENA. Volume IV. Recombination and Fast Collisions of Heavy Particles. Massey, H. S. W.; Burhop, E. H. S.; Gilbody, H. B. International Series of Monographs on Physics. Oxford; Clarendon Press (1974). 3185p.

The subject covers recombination; collision processes involving energetic ionized and neutral beams of atoms and molecules; elastic collisions between particle beams and neutral atoms and molecules; inelastic collisions between atomic systems–theoretical considerations; charge–changing and ionizing collisions–experimental methods and results including theoretical analysis; collisions involving excitation–experimental methods and discussion of results obtained. (UK)

1322 HIGH RESOLUTION MEASUREMENTS OF THE 2^3S CUSP AND THE 2^2S RESONANCE IN ELASTIC ELECTRON–HELIUM SCATTERING. Cvejanovic, S.; Comer, J.; Read, F. H. (Univ. of Manchester, Eng.). J. Phys., B (London); 7: No. 4, 468-477(11 Mar 1974).

The cusp in the cross section for the elastic scattering of electrons by helium atoms at the energy of the 2^3S threshold was measured at scattering angles from 25 to 100°. High resolution measurements at 90° have shown that the s wave phase shift is 107 ± 11° at this energy. The energy of the 2^2S resonance was accurately calibrated from the position of the cusp, and it was found to be at 19.367 ± 0.009 eV, with a natural width of 9 ± 1 MeV. The s wave phase shift at the resonance energy was found to be 106 ± 3°. The 2^1S cusp was also studied. (auth)

1323 ELECTRON 2^1P HELIUM SCATTERING CROSS SECTIONS USING GLAUBER THEORY. Terebey, J. Z. (Univ. of Indiana, Bloomington). J. Phys., B (London); 7: No. 4, 460-467(11 Mar 1974).

The electron-2^1P helium differential cross section is calculated using the Glauber theory for several energies. The results are compared with the recent experimental data of Opal and Beaty (J. Phys. B. Atom. Molec. Phys.; 5: 627-35(1972)), the extensive first Born calculations of Truhlar et al (Phys. Rev. A.; 1: 778-802(1970)) and the Coulomb projected Born calculations of Hildago and Geltman (J. Phys. B. Atom. Molec. Phys.; 5: 617-25(1972)). Also, the total cross section is calculated and the results compared with the experimental results of Jobe and St John (Phys. Rev.; 164: 117-21 (1967)). In general, the results for 2^1P helium show the same improvement as Tai et al (Phys. Rev.; A1: 1819-54 (1970)) demonstrated for the hydrogen differential cross sections. (auth)

1324 ELECTRON IMPACT SPECTRUM OF He IN THE VICINITY OF THE n = 2 THRESHOLDS. Golden, D. E.; Schowengerdt, F. D.; Macek, J. (Univ. of Nebraska, Lincoln). J. Phys., B (London); 7: No. 4, 478-487(11 Mar 1974).

The derivative of the electron transmission spectrum of helium was directly measured for electron energies between about 19.2 and 21.2 eV. Effective range theory was used to extrapolate the 2^2S state of He^- across the 2^3S threshold of He. Such extrapolation produces a peak in the energy derivative of the transmitted current at the 2^3S threshold which was used to calibrate the electron energy scale. This calibration technique was used to identify the positions of the other n = 2 thresholds. The position of the dip in the elastic cross section due to the 2^2S state of He^- is thus established at 19.35 ± 0.02 eV. Two additional structures were observed between [He^- (2^2S)] and [He (2^3S)] and three between [He (2^3S)] and [He (2^1S)] in agreement with the results of Golden and Zecca [Phys. Rev.; A1: 241-9 [1970]]. Several additional features in the spectrum are also discussed. (auth)

1325 ELASTIC SCATTERING OF ELECTRONS BY NEON AND ARGON ATOMS AND HYDROGEN MOLECULES. Khare, S. P.; Shobha, P. (Government Science Coll., Gwalior, India). J. Phys., B (London); 7: No. 3, 420-427(21 Feb 1974).

Elastic scattering of electrons by neon and argon atoms and hydrogen molecules are considered in the plane wave approximation. Comparison of the present results with the available experimental data indicates that the polarization potential is of importance even up to incident energies as high as 800 eV. (auth)

1326 CHEMI-IONIZATION REACTIONS INVOLVING METASTABLE HELIUM ATOMS. Riola, J. P.; Howard, J. S.; Rundel, R. D.; Stebbings, R. F. (Univ. of Kansas, Kansas City). J. Phys., B (London); 7: No. 3, 376-385(21 Feb 1974).

Total chemiionization cross sections were measured at thermal energy (0.06 eV mean energy in the center of mass reference frame) for collisions of helium 2^1S and 2^3S metastable atoms with Ar, Kr, Xe, N_2, O_2, NO, CO, CO_2, N_2O and CH_4, using a crossed beams technique. The results in several cases are in disagreement with earlier published values. A careful analysis of the various data has not revealed the cause of the discrepancy. (auth)

1327 ELASTIC SCATTERING OF POSITRONS IN NEON AND ARGON AND PHASE SHIFT ANALYSIS FROM 4 eV TO INELASTIC THRESHOLDS. Jaduszliwer, B.; Paul, D. A. L. (Univ. of Toronto). Can. J. Phys.; 52: No. 3, 272-277(1 Feb 1974).

The transmission of positrons through neon gas was studied in the elastic region below the positronium formation threshold at energies from 4 to 14 eV, and the same experiment was carried out for argon from 4 to 8 eV. By repeating the measurements using three values of magnetic field along the scattering chamber, in the direction of transmission, some sensitivity to individual phase shifts is obtained, and a phase shift analysis was carried out. The l = 0, 1, and 2 shifts are each parametrized as a two term power expansion in the wave number, while the forms of δ_3, δ_4 are assumed from theory. The results of the analysis are compared with published theories and indicate the need for more accurate calculations, particularly for argon. The total cross sections deduced for neon are in disagreement with the smaller values measured by Canter, Coleman, Griffith, and Heyland, but the cross sections for argon are in agreement with theirs. (auth)

1328 CLOSE COUPLING. Seaton, M. J. (Univ. College, London). Comput. Phys. Commun.; 6: No. 6, 247-256(Dec 1973).

A method involving reduction to a system of linear algebraic equations is described for the solution of the coupled integro-differential equations of electron–atom collision theory. The collisions $e + C^{3+}$ and $e + O^{2+}$ are considered as examples. (JFP)

1329 NUMERICAL METHODS IN ASYMPTOTIC REGIONS. Norcross, D. W. (Univ. of Colorado, Boulder). Comput. Phys. Commun.; 6: No. 6, 257-264(Dec 1973).

Two problems encountered in electron-atom collision calculations which involve interactions at large radial distances are discussed. One major problem is solution of the set of coupled second-order differential equations routinely obtained when asymptotic boundary conditions are imposed in coupled channel methods. The second problem is the evaluation of the radial integrals over products of Coulomb functions which are required in Coulomb-Born and distorted wave methods. (auth)

1330 POLARIZED ORBITAL METHODS. Callaway, J. (Louisiana State Univ., Baton Rouge). Comput. Phys. Commun.; 6: No. 6, 265-274(Dec 1973).

The basic approximations involved in polarized orbital methods are discussed, and points of difference between common variants are described. Differing methods are evaluated in regard to the calculation of phase shifts for elastic scattering of electrons by hydrogen and helium at energies below the lowest excitation threshold. (auth)

1331 MATRIX VARIATIONAL METHOD. Nesbet, R. K. (IBM Research Lab., San Jose, CA). Comput. Phys. Commun.; 6: No. 6, 275-287(Dec 1973).

A general formalism is described for the matrix variational method, applicable to multichannel electron scattering by a many-electron atom, for energies below the first ionization threshold. Physical interpretation of the method and its relation to others (close-coupling and polarized orbital methods) are discussed. Recent computations by this method of elastic and inelastic electron scattering are reviewed. (auth)

1332 R-MATRIX METHOD IN ATOMIC PHYSICS. Burke, P. G. (Queen's Univ., Belfast). Comput. Phys. Commun.; 6: No. 6, 288-302(Dec 1973).

The R-matrix method and related theories are first briefly reviewed. Then the application of the method in the calculation of atomic polarizabilities, photoionization cross sections, multiphoton processes and electron-atom scattering is discussed. Finally, computer program packages which implement these calculations are described. (auth)

1333 FREDHOLM CALCULATION OF ELECTRON–ATOM SCATTERING AMPLITUDES USING L^2 BASIS SETS. Reinhardt, W. P. (Harvard Univ., Cambridge, MA). Comput. Phys. Commun.; 6: No. 6, 303-315(Dec 1973).

Use of square integrable (L^2) basis functions in calculating approximations to the Fredholm determinant for elastic and inelastic scattering processes is described. Results of calculations for purely elastic e-H and e-He phase shifts are given, as well as elastic scattering cross sections for e-H scattering at energies where ionization channels are open. (auth)

1334 ANALYTICAL AND NUMERICAL PROCEDURES IN THE APPLICATION OF MANY-BODY GREEN'S FUNCTION METHODS TO ELECTRON–ATOM SCATTERING PROBLEMS. Thomas, L. D.; Yarlagadda, B. S.; Csanak, G.; Taylor, H. S. (Univ. of Southern California, Los Angeles). Comput. Phys. Commun.; 6: No. 6, 316-330(Dec 1973).

The analytical and numerical procedures used in calculation of e^--He elastic scattering phase shifts in the generalized random phase approximation (GRPA) and e^--He inelastic cross sections in the random phase approximation (RPA) are presented. The pertinent equations are first written in general form and analyzed into spin and angular momentum variables. In both elastic and inelastic work the transition density matrix was represented on a basis. Finite basis sets were also used to construct the static-exchange and polarization parts of the optical potential. The elastic scattering phase shifts were then evaluated numerically. In the inelastic work all calculations were done numerically. As an illustration of the usefulness of these methods, some typical results and computational times are given. (auth)

1335 USE OF ANALYTICITY IN ATOMIC SCATTERING CALCULATIONS. Nuttall, J. (Univ. of Western Ontario, London). Comput. Phys. Commun.; 6: No. 6, 331-335(Dec 1973).

Some of the ways in which analyticity was used in the past and might be used in the future to aid in performing calculations of atomic scattering amplitudes are summarized. Included are extrapolation methods, contour distortion techniques and the determination of resonance positions. (auth)

1336 EIKONAL THEORY OF ELECTRON–ATOM COLLISIONS. Joachain, C. J. (Univ. Libre, Brussels). Comput. Phys. Commun.; 6: No. 6, 358-371(Dec 1973).

The application of eikonal methods to electron-atom scattering is reviewed. After recalling the basic features of the eikonal approximation, the Glauber theory, the eikonal-Born series method, the eikonal optical model theory and the eikonal distorted wave approach are discussed. A survey is also given of recent results obtained for electron-hydrogen and electron-helium collisions at intermediate energies. (auth)

1337 HIGHER BORN, PADE, AND SCHWINGER VARIATIONAL METHODS. Moiseiwitsch, B. L. (Queen's Univ., Belfast). Comput. Phys. Commun.; 6: No. 6, 372-376(Dec 1973).

The application of higher Born approximations and, in particular, the second Born approximation to the evaluation of scattering amplitudes and differential cross sections for electron-atom impact is discussed, and the relation between Padé approximants and the Schwinger variational method is examined. A new procedure involving an expansion of the wave function as a sum of plane waves, known as the Fredholm integral method, is shown to be securely based on Schwinger's variational principle and has its value assessed by consideration of simple potential scattering problems. (auth)

1338 DEPOLARIZATION OF AN EXCITED ATOM BY COLLISION WITH ANOTHER ATOMIC PARTICLE. Duman, E.L. Opt. Spectrosc. (USSR) 35: No. 2, 113-117 (Aug 1973).

An approximation method is developed for calculating depolarization cross sections of an excited atom with an arbitrary total angular momentum. From a comparison of depolarization cross sections obtained by the approximation method and exact numerical calculation, it is concluded that the approximate solution agrees with the exact calculation to within 10–15%. A function is obtained which describes the dependence of the calculated depolarization cross sections of an excited atom with j=1 on the exponent "n". Assuming that this function is valid for any total angular momentum of an excited atom, a formula is derived for the depolarization cross sections of any momentum j when it is necessary to approximate the potential energy of two atoms by the relation B/R^n, $n>3$. (auth)

1339 HIGH RESOLUTION STUDIES OF ELECTRON EXCITATION. II. The 3^1D, 4^1D, AND 4^1D STATES OF HELIUM: FEATURES IN THE n = 4 EXCITATION FUNCTIONS. Heddle, D. W. O.; Keesing, R. G. W.; Kurepa, J. M. (York Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 337: No. 1610, 435-441(26 Mar 1974).

Excitation functions of the 4^1D, 3^1D and 4^1D states of helium are presented for energies within about 1 eV of threshold. A series of broad features and some sharp features are found, and their interpretation is discussed. The broad features appear to be shape resonances and to occur, at least in part, as a result of cascade from F states. It is suggested that the prominent features in the 4S excitation functions are due to Feshbach resonances having configurations $1s\,5s^2$ and $1s\,5p^2$. A very small feature at the threshold of both 4D functions is interpreted as a $1s\,4d^2$ Feshbach resonance. (auth)

1340 SPECTRAL EXCHANGE IN IMPACT BROADENING OF THE ROTATIONAL STRUCTURE. Burshtein, A. I.; Strekalov, M. L.; Temkin, S. I. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 66: No. 3, 894-906 (Mar 1974). (In Russian).

The rate of spectral exchange between the rotational structure components in isotropic space and an external field is determined. Spectral exchange is found to be essentially a nonadiabatic phenomenon, and its treatment in current classical theory in the elastic collision approximation, as well as its complete absence in nonadiabatic quantum theory, is erroneous. After suitable adjustment the two theories can be made consistent with each other. In this case spectral exchange involves an unusual transformation (collapse) of the Stark and rotational structures with increase of pressure. By studying the collapse one can tell whether the collisions are "strong" or "weak" and determine the degree of their nonadiabaticity. (auth)

1341 MONTE CARLO METHODS FOR CLASSICAL COLLISIONS BETWEEN ELECTRONS AND ATOMS. Percival, I. C. (Univ. of Stirling, Scotland). Comput. Phys. Commun.; 6: No. 6, 347-357(Dec 1973).

The need for classical cross sections is briefly presented. The numerical methods and computing techniques needed to obtain an electron atom collision cross section by the Monte Carlo classical trajectory method are described and illustrated by examples. (auth)

1342 EFFECT OF ELASTIC COLLISIONS ON NONLINEAR INTERFERENCE PHENOMENA. Barantsov, V. I.; Bolotskikh, L. T.; Popov, A. K. (Inst. of Physics, Krasnoyarsk, USSR). Zh. Eksp. Teor. Fiz.; 66: No. 3, 866-874(Mar 1974). (In Russian).

The possibility of appearance of the Dicke effect in nonlinear high resolution optical spectroscopy is studied. The interaction between a three-level system (one of the transitions of which is microwave) and two optical fields is considered. The effect of elastic collisions, in which the atomic oscillator phase is weakly perturbed, on resonant nonlinear interaction between optical fields is considered within the framework of the strong collision model. A solution of the equation set for the density matrix which includes the collision integral is obtained by the method of successive approximations. It is shown that when one of the microwave transition levels is that of the ground state, elastic collisions may lead to a significant narrowing of the nonlinear resonance on the contour of the optical transition spectral line. The sharp structure in this case is a reflection of the microwave transition relaxation characteristics. The possibility is considered of employing the phenomena under consideration in nonlinear spectroscopy of high resolution. The latter permits one to study simultaneously the characteristics of both optical and microwave transitions by optical methods. (auth)

1343 VELOCITY DISTRIBUTION RELAXATION DUE TO INELASTIC COLLISIONS. Kol'chenko, A. P.; Rautian, S. G.; Troitskii, Yu. V.; Shalagin, A. M. (Inst. of Spectroscopy, Moscow). Zh. Eksp. Teor. Fiz.; 66: No. 3, 857-865(Mar 1974). (In Russian).

A new mechanism is proposed which can lead to efficient change in the velocity of an excited atom, viz., inelastic collisions. Along with the familiar mechanisms (resonant exchange by excitation, radiation capture, collisions with a small impact parameter) the present mechanism also leads in a number of cases to a strong collision model. The effect of inelastic collisions on the velocity distribution of excited atoms is analyzed within the framework of the strong collision model. Stationary conditions, relaxation processes and the spatially inhomogeneous problem are considered. It is shown that in a number of cases the mechanism may yield an appreciable contribution to the relaxation of the velocity distribution. (auth)

1344 DETACHMENT OF WEAKLY BOUND ELECTRONS IN SLOW COLLISIONS BETWEEN ATOMIC SYSTEMS. Dalidchik, F. I. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 66: No. 3, 849-856(Mar 1974). (In Russian).

Detachment processes involving weakly bound electrons in slow collisions between atomic systems are discussed. The role of excited states of inner electrons in such processes is elucidated. It is shown that in a number of cases autoionization of the quasimolecule is determined mainly by direct interaction between the residues (by the diagonal and off-diagonal parts). The spectrum of the liberated electrons is found in the presence or absence of pseudointersection of terms of the inner electrons. Effects related to the "inelastic" ionization channels are discussed. They may manifest themselves in the anomalous energy dependence of colliding particles in the initial part of the spectrum or in the appearance of characteristic near-threshold peculiarities. The results of the theory are employed for interpreting available data on electron detachment in collisions between alkali metal negative ions or neutral atoms and noble gas atoms. (auth)

1345 DOUBLE DELAYED MAXIMA IN THE IONIZATION OF KRYPTON 3d ELECTRONS BY FAST CHARGED PARTICLES. Nichols, W. D.; Purcell, J. E.; Manson, S. T. (Georgia State Univ., Atlanta). Chem. Phys. Lett.; 25: No. 3, 399-401(1 Apr 1974).

The energy loss cross section for fast charged particles ionizing krypton 3d electrons is found to have two delayed maxima for certain incident energy ranges. (auth)

1346 PHOTODISSOCIATIVE FORMATION OF ION PAIRS FROM MOLECULAR HYDROGEN AND THE ELECTRON AFFINITY OF THE HYDROGEN ATOM. McCulloh, K. E.; Walker, J. A. (National Bureau of Standards, Washington, DC). Chem. Phys. Lett.; 25: No. 3, 439-442(1 Apr 1974).

Photodissociative production of ion pairs from H_2 was observed in the wavelength range 706 to 718 Å at spectral resolutions of 0.4 and 0.22 Å. From measured thresholds for production of H^-

from H_2 molecules in each of the three lowest rotational states, the lower bound EA(H) ≥ 0.754 ± 0.002 eV is obtained, in excellent agreement with the theoretical electron affinity of 0.75421 eV. For formation of D^- from D_2, a threshold assigned to molecules in the rotational state J = 2 was measured, from which the bound EA(D) ≥ 0.757 ± 0.005 eV is obtained. Negative ion yield curves are presented for hydrogen. (auth)

1347 APPLICATION OF THE JABLONSKI THEORY TO THE CALCULATION OF THE SHAPE OF MERCURY RESONANCE LINE: 2537A BROADENED BY KRYPTON. Grycuk, T. (Univ., Warsaw). Acta Phys. Pol.; A45: No. 4, 525-538(Apr 1974).

The shape of the Hg resonance line—2537 Å broadened by krypton was calculated by means of the Jabloński theory, taking into account the simultaneous interaction of many perturbing atoms and the collision effects additionally modifying the statistical intensity distribution. In order to calculate the part of the intensity distribution originating in two-particle interactions, a quasiclassical approximation was used, assuming an interatomic potential of the van der Waals type: $V(R) = -C_6^g R^{-6}$. The constant C_6^g for the ground state of the couple $Hg(6^1S_0) + Kr(4^1S_0)$ was obtained utilizing some of the literature data, and the constants C_6^1 and C_6^3 for the excited state: $Hg(6^3P_1) + Kr(4^1S_0)$ were calculated in the dipole–dipole approximation considering, however, the splitting of this level in an axial field of the colliding atoms Hg–Kr. The intensity distribution in the considered line was calculated for the two values of the number densities of the krypton atoms: 45.5 and 69.4 Amagat, corresponding to the conditions of De Kluiver experiments reported several years ago. A comparison of the calculated intensity distributions with the experimental ones shows that except for the short-wave wing of the line where blue satellite bands appear, making a comparison impossible, qualitative agreement is sufficiently good; the theoretical profiles, however, have a somewhat greater width and asymmetry. It seems that these discrepancies would be decreased if the repulsive part of the interaction potential were taken into account and if the numerical calculations were performed more accurately. (auth)

Atomic Theory

Refer also to abstracts 1263, 1340, and 1487.

1348 SOME EVIDENCE ABOUT THE DYNAMICAL GROUP SO(4,2) SYMMETRIES OF THE PERIODIC TABLE OF ELEMENTS. Odabasi, H. (Univ. of Colorado, Boulder). Int. J. Quant. Chem., Symp.; No. 7, 23-33(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

The subject of the order of electron shells in neutral atoms (Madelung's rule) and in highly ionized ions (hydrogenic order) is reviewed. The results and the predictions of the central field approximations are surveyed. Since the symmetries of Madelung's rule can be explained by the chain SO(4,2) → SO(3,2) → SO(3) ⊗ SO(2) and since there are two irreducible representations of SO(3,2), one with (n + l) = even and the other with (n + l) = odd, into which the SO(4,2) representation, whose multiplicity pattern coincides with the structure of periodic table, reduces, when considered along periods the physical properties of normal configurations of atoms or lightly ionized ions are expected to fall on separate smooth curves according to whether (n + l) is even or odd. By using observed and theoretical data it is shown that this is indeed the case. In particular it is also demonstrated that if along the periods three points of the same kind are known, corresponding to the ionization potentials for normal states of atoms, the fourth point can be extrapolated very accurately. For example, by this method the ionization potential for the normal state of francium is determined to be $^{87}(IP)_I = 32060 \pm 30\ cm^{-1}$. (auth)

1349 COMMENT ON THE GROUP THEORETICAL JUSTIFICATION OF THE AUFBAU SCHEME. Novaro, O. (Univ., Mexico City). Int. J. Quant. Chem., Symp.; No. 7, 53-56(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

The question of the shift from the energy ordering by n for the hydrogen-like ions to the (n + l,n) ordering for neutral atoms is examined. Both energy rules are given a geometrical interpretation showing that simple analytical images are associated with them and the intermediate situation where a gradual change between the hydrogenic shells into the "Aufbau" ordering occurs. The introduction of the energy dependence on n and l is depicted as a symmetry-breaking mechanism of the original symmetry of hydrogen-like systems, which leads to the correct subshell ordering. (auth)

1350 RECENT CI METHODS FOR THE CALCULATION OF PAIR CORRELATIONS AND MORE-ELECTRON CLUSTERS IN GROUND-STATE ATOMS. Sinanoglu, O. (Yale Univ., New Haven). Int. J. Quant. Chem., Symp.; No. 7, 57-63(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

The equations and approximations of ground-state "many-electron theory of atoms and molecules" (MET) of Sinanoglu, a 1955 atomic theory of Yilmaz, and the equations and approximations of Brueckner theory and the Bethe–Goldstone equations for nuclei in which all correlations are coupled into a superdouble self-consistency and its atomic form by Nesbet are compared. It is shown that as noted recently by Condon and others, recent atomic calculations by the partial CI procedures of MET are in agreement with MET approximations, while calculations with Brueckner theory and the Bethe–Goldstone equations, though essential for nuclei, have so far not been performed for atoms. (auth)

1351 EFFECTIVE PRINCIPAL QUANTUM NUMBERS AND INTEGRAL TRANSFORM FUNCTIONS. Gruninger, J.; Clements, W.; Jaworowicz, S. (West Virginia Univ., Morgantown). Int. J. Quant. Chem., Symp.; No. 7, 103-109(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

A relation between the effective principal quantum numbers of Hartree–Fock orbitals and the domains of integral transform orbitals, with homogeneous weight functions, is defined. This relation is used to determine the nonlinear parameters of Hulthén type 0s and 1p orbitals for the ground states of the second and third rows of atoms and to explain the failure of the Hulthén 2d function as an adequate representation of a 3d Hartree–Fock orbital. (auth)

1352 ENERGIES OF TWO-ELECTRON ATOMS AND IONS. Callan, E. J. (Aerospace Research Labs., Wright-Patterson AFB, OH). Int. J. Quant. Chem., Symp.; No. 7, 111-115(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

Inner truncation of the Coulomb interelectron repulsion leads to a simple analytic expression for two electron atom energies which agrees well with results of Pekeris, Drake and Dalgarno, and others for ground, singly, and doubly excited states for a variety of Z values. (auth)

1353 SHAPE OF ATOMIC ORBITALS. Cusachs, L. C. (Loyola Univ., New Orleans); Aldrich, H. S. Int. J. Quant. Chem., Symp.; No. 7, 231-237(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

Radial moment analysis of accurate atomic orbitals and of simplified analytic representations provides insight into the effect of radial nodes on orbital shape. The concept of effective principal quantum number is used to extend simple analytic representation to the heavier elements. (auth)

1354 SEPARATION THEOREM FOR FIRST-ORDER PAIR-CORRELATION EQUATIONS. Langhoff, P. W. (Indiana Univ., Bloomington). Int. J. Quant. Chem., Symp.; No. 7, 443-448(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

The first-order pair-correlation equations devised by Sinanoglu are separated into one-electron perturbation equations appropriate for the interactions of individual orbitals with an external electromagnetic plane wave. Solutions of the latter equations, obtained employing variational and related computational techniques, provide compact expressions for both intra- and intershell pair functions and energies. (auth)

1355 PROGRAM FOR THE EXTRACTION OF RADIATIVE LIFETIMES FROM EXPERIMENTAL BEAM–FOIL INTENSITY DECAY DATA. Irwin, D. J. G.; Livingston, A. E. (Univ. of Alberta, Edmonton). Comput. Phys. Commun.; 7: No. 2, 95-113(Feb 1974).

The computer program HOMER written in FORTRAN IV for the IBM 360/67 computer is described for the analysis of experimental beam–foil intensity decay data into a sum of exponential terms, each with an amplitude and lifetime parameter. The most apt number of parameters and the optimum values of each is to be determined, together with estimates of the standard deviation. Beam–foil spectroscopy is useful for the experimental determination of the radiative lifetime of an excited level of an atom or ion. (JFP)

1356 NONRELATIVISTIC SCF ATOMIC PROGRAM TO COMPUTE ONE-ELECTRON ENERGIES, TOTAL ENERGIES, AND SLATER INTEGRALS. Wood, J. H.; Boring, M. (Los Alamos Scientific Lab., NM). Comput. Phys. Commun.; 7: No. 2, 73-84(Feb 1974).

The computer program HERSKLZARE written in FORTRAN IV for the CDC 6600 and CDC 7600 computers is described for the performance of nonspin-polarized nonrelativistic self-consistent field calculations for atoms and ions through the use of an approximate exchange potential. After calculating central field radial wave functions and eigenvalues, the total energy, I, F, G integrals, etc., can be calculated. (JFP)

1357 RYDBERG CONSTANT. Series, G. W. (Univ. of Reading, Eng.). Contemp. Phys.; 15: No. 1, 49-68(Jan 1974).

The Rydberg constant is one of the most important constants of atomic physics because of its connection with the fundamental atomic constants (e, h, m_e, c), and because of the high accuracy with which it can be determined. In this review the Rydberg constant is seen in its historical context, in relation to the spectra of hydrogen and ionized helium, and in relation to the atomic constants in general. Some of the problems which arise in its experimental determination are discussed, and recent work using the techniques of high resolution spectroscopy is described. A new technique—saturated absorption spectroscopy—is also described. This promises an improvement in accuracy by at least an order of magnitude. It is shown how work now in progress calls for a new definition of the base unit of length. (auth)

1358 ROTATION–VIBRATION COUPLING IN DIATOMIC MOLECULES AND THE FACTORIZATION METHOD. II. CLOSED FORM FORMULAS FOR THE MORSE–PEKERIS INTENSITIES. Badawi, M.; Bessis, N.; Bessis, G.; Hadinger, G. (Univ., Lyon). Can. J. Phys.; 52: No. 2, 110-119(15 Jan 1974).

It is shown that, by applying an "accelerated" ladder operational formalism or an equivalent matrix procedure, one can obtain, easily, for the case of a Morse–Pekeris potential, a closed form expression of the rotation–vibration nuclear dipole moment matrix elements. This explicit expression, which is valid for any degree k of the dipole moment Taylor's expansion, allows the determination of the rotation–vibration intensities for any $\Omega vJ \rightarrow \Omega' v' J'$ transition. (auth)

1359 EXACT RESULTS ON THE STRUCTURE OF MATTER. Thirring, W. (Univ., Vienna). Acta Phys. Austr., Suppl.; 11: 493-525(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

It is considered what can be rigorously deduced from a Hamiltonian governing a system of N nonrelativistic particles interacting with Coulomb and Newton potentials, which treated quantum mechanically should give a good description of atoms, molecules, and macroscopic and cosmic bodies. The most elementary properties of this Hamiltonian namely the position of E_0 and some properties of level densities as they are reflected in the thermodynamic functions are treated. (JFP)

1360 DEVELOPMENT OF A NONLOCAL ONE PARTICLE EXCITATION HAMILTONIAN FOR ATOMIC, MOLECULAR, AND SOLID STATE SYSTEMS. Kunz, A. B.; Collins, T. C. (Univ. of Illinois, Urbana). J. Phys., B (London); 7: No. 3, L69-L72(21 Feb 1974).

A general excitation operator of the generalized Hartree-Fock form is developed. This Hamiltonian specifically includes the electron-hole interaction. It is shown both that this operator possesses a Koopmans' theorem and is based upon a variation principle. (auth)

1361 X RAY SCREENING CONSTANTS. Burr, A. F.; Carson, J. K. (New Mexico State Univ., Las Cruces). J. Phys., B (London); 7: No. 4, 451-459(11 Mar 1974).

The effect of the nuclear charge on any given orbital electron is reduced by the screening effect of the other electrons in the atom. Values of σ_2, the Sommerfeld constant which is a measure of this screening, can be obtained from the difference between energy levels belonging to a spin doublet. New values of $\sigma_2(Z)$, with probable errors, were calculated for the L_2L_3, M_2M_3, M_4M_5, N_2N_3, N_4N_5, N_6N_7, O_2O_3, and O_4O_5 doublets over the entire range of atomic numbers, Z. The method used is shown to be superior to the usually employed Sommerfeld's approximation. A study of σ_2 against Z yields several interesting conclusions, the most important one being that the best calculated values for the binding energies of electrons in the transuranium elements give too large a separation between the members of the L shell spin doublet. Several anomalous energy level spacings are pointed out, and new values for the L shell spin doublet separation for the transuranium elements are given. (auth)

1362 PRINCIPLES OF ATOMIC PHYSICS AND ELECTRONICS. Nelkon, M. London; Heinemann Educational Books (1972). 190p.

It is stated that the book deals with the principles of atomic physics and electronics to G.C.E. Advanced and Special standards. It begins with the forces on electrons and ions in electric and magnetic fields, and the energy of these particles. Radioactivity and the atomic nucleus are then discussed, and there is an account of mass spectrometers, detectors of ionizing particles and radiations, and nuclear energy. This is followed by consideration of the electrons round the nucleus (the extra-nuclear atom), with sections on energy levels, optical spectra, the laser principle, x-rays, and the wave-particle aspect. An introduction is given to the principles of diode and triode valves and the cathode-ray oscillograph, and to semiconductors and transistors (including sections on transistor switching and logical gates, in view of their computer application). A list of some experiments is given; a brief note on error in counting in radioactivity experiments; an account of the principles of digital display tubes, scalers and ratemeters; an introduction to valve and transistor couplings; and further details of the cathode ray oscilloscope, and of the Rutherford scattering law. Recent examination questions were added in this (fourth) edition, and the text was revised in SI units. (UK)

1363 FADDEEV-TYPE COUPLED EQUATIONS. Chen, J. C. Y. (Univ. of California, San Diego, La Jolla). Comput. Phys. Commun.; 6: No. 6, 336-346(Dec 1973).

The application of the Faddeev-type coupled equations in atomic problems has not so far produced any substantially new results nor solved any new problems. The reason for this lack of new progress is discussed. A review of new attempts and new procedures is presented. (auth)

1364 PASSAGE OF POLARIZED RADIATION THROUGH THE RESONANT MEDIUM. Adonts, G. G. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 8: No. 4, 241-247(1973). (In Russian).

The passage of polarized radiation through the resonant medium with due regard for the degeneration of atomic levels is examined. The medium consists of two-level atoms with energy E_1 and angular momentum j_1 in ground state and E_2 and j_2 accordingly in excited state. The atomic level shifts as well as the index of refraction of medium for circularly and linearly polarized waves are obtained. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 1808.

1365 EXISTENCE AND STRUCTURE OF MAGNETOHYDRODYNAMIC SHOCK WAVES. Conley, C. C. (Univ. of Wisconsin, Madison); Smoller, J. A. Compt. Rend., Ser. A, B; 277: No. 9, 387-389(3 Sep 1973). (In French).

When all the viscosity effects are taken into consideration, the magnetohydrodynamic equations constitute a nonlinear parabolic system of partial differential equations. The solving of these equations can be reduced to the study of a system of ordinary differential equations. By introducing hypotheses on the pressure, entropy, and internal energy, it is shown that if the system of ordinary differential equations admits no more than 4 equilibrium points, slow and fast shocks of any intensity lead to structure for all values (positive) of the 4 viscosity parameters. (FR)

1366 LOCAL BEHAVIOUR OF CONGRUENCES IN RELATIVISTIC MAGNETOFLUIDS. Date, T. H. (Shivaji Univ., Kolhapur, India). J. Shivaji Univ.; 5: No. 10, 123-130(1972).

The local behavior of space-like and time-like congruences are studied in the context of relativistic magnetohydrodynamics. The fluid is thermodynamical perfect with infinite electrical conductivity and variable magnetic permeability. It is shown that if there is no electric charge in the magnetofluid, the magnetic field vector is orthogonal to the rotation vector associated with the flow. The dependence of entropy variation on the magnetic permeability is established. Applications to galactic cosmology, gravitational collapse and pulsars are discussed. (auth)

1367 MAGNETOFLUID DYNAMICS FOR ENGINEERS AND APPLIED PHYSICISTS. Cramer, K. R.; Pai, S. I. New York; McGraw-Hill Book Company (1973). 347p. $19.50.

A detailed description is given of the theoretical background of magnetofluiddynamics (MFD), including a derivation of the governing equations and principles for continuum fluids. Particular stress is placed on the relation of MFD theory to special problems important to aerospace engineers and applied physicists. After deriving the MFD equations from the physical laws to provide an understanding of the equations and pertinent terms, a detailed study is made of one-dimensional MFD flow because of its importance in applications, and the associated heat and pressure losses are calculated. The new wave phenomena important in communication and astrophysical problems are described. In particular, the essential points of wave motion in electrically conducting fluids are discussed with special emphasis on phenomena which differ from wave motions in neutral gases. The application of MFD theory to engineering problems such as power generation, pumps, and accelerators for space propulsion is considered, and some extensions and improvements of MFD theory are described. (IAA)

1368 SOME EXTREMUM PRINCIPLES FOR MIXED BOUNDARY VALUE PROBLEMS IN MAGNETOHYDRODYNAMIC PIPE FLOW. Smith, P. (Univ. of Keele, Eng.). Z Angew. Math. Mech.; 53: 791-796(Dec 1973).

Some extremum principles are established for the rectilinear flow of a fluid in a pipe under the influence of a uniform magnetic field. The pipe walls are composed of nonconducting and conducting segments. Bounds are deduced for the mass-flow rate which can be used to construct asymptotic formulas valid for large Hartmann numbers. Several illustrative examples are included. (auth)

1369 MHD COUETTE FLOW BETWEEN TWO NONCONDUCTING PARALLEL WALLS WITH VARIABLE SUCTION. Part I. Dube, S. K. (Analele Stiintifice Ale Universitatii, Iasi). An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ia; 17: No. 2, 491-501(1971).

Many MHD problems are studied under the small magnetic Reynolds number assumption. This paper relaxes this assumption and studies instead the highly unrealistic case when the magnetic Reynolds number equals the viscous Reynolds number and displays the exact solution for the stated problem. The viscous skin friction is computed, but the electromagnetic contribution to the "friction" is not considered. (App. Mech. Rev.)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 1401 and 1809.

1370 FUTURE OF SCIENCE (ELEMENTARY PARTICLE ACCELERATORS OF NEXT GENERATIONS). Markov, M. A. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk; 111: No. 4, 719-742(Dec 1973). (In Russian).

The primary questions on the property of matter faced by high energy physics are discussed. The history of high energy physics is briefly outlined, and an indication is given of the problems to be solved. The place of accelerators in the solutions of these problems is discussed. (JSR)

Electromagnetic

1371 (DESY-73-61) INCLUSIVE PHOTOPRODUCTION OF PIONS, KAONS, AND PROTONS AT 6 GeV. Burfeindt, H.; Buschhorn, G.; Genzel, H.; Heide, P.; Koetz, U.; Mess, K. H.; Schmueser, P.; Sonne, B.; Vogel, G.; Wiik, B. H. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Dec 1973. 41p. Dep. NTIS (U. S. Sales Only) $5.25.

The invariant cross sections for inclusive photoproduction of charged pions, kaons, and protons were measured at DESY in the photon fragmentation region at a photon energy of 6 GeV. For $x = p_\parallel^{cm}/p_{\parallel max}^{cm}$ positive the average transverse momentum for π^+ and K^- was found to be roughly 420 MeV/c as compared to an average transverse momentum of about 550 MeV/c for K^+ and protons. The π^+/π^- ratio is close to one at small values of the transverse momentum $p_\perp$ but increases with increasing values of $p_\perp$. This indicates that scaling is violated at large transverse momenta (or low missing masses). The same general behavior is also observed in the K^+/K^- ratio, although here the ratio is significantly larger than one even at small transverse momenta. A comparison with preliminary data at 18 GeV supports this conclusion. The comparison further indicates that the largest violations of scaling occur in the "exotic" reaction $\gamma p \to K^- X$. The data are also analyzed according to the triple Regge model of inclusive reactions, and the effective trajectories were determined. (auth)

1372 (DL/R-32) PROCEEDINGS OF THE MEETING ON EXPERIMENTAL TESTS FOR EXOTIC ELECTROMAGNETIC CURRENTS, DARESBURY LABORATORY, 6 JULY 1973. Daresbury Study Weekend Series No. 7. Gabathuler, E.; Shaw, G. (eds.). (Science Research Council, Daresbury (UK). Daresbury Nuclear Physics Lab.). 1973. 116p. (CONF-730739-).

The conference included five papers. Separate abstracts were prepared for all papers. (JFP)

For abstracts of individual papers see: 1373, 1384, 1385, 1406, and 1407.

1373 (DL/R-32, pp 1-41) CHARGED PION PHOTOPRODUCTION IN THE $\Delta(1236)$ REGION: IS THERE EVIDENCE FOR EXOTIC CURRENTS? Benz, P.; Soeding, P. (Deutsches Elektronen-Synchrotron, Hamburg). 1973.

From meeting on experimental tests for exotic electromagnetic currents; Daresbury, UK (6 Jul 1973).

Photoproduction of the $\Delta(1236)$ is considered with respect to the possibility of the existence of an electromagnetic isotensor current, arising from a comparison of cross sections for photoexcitation of the $\Delta(1236)$ on protons and neutrons, and the possibility of a violation of time reversal invariance. Both these possibilities depend on precise photoproduction cross sections for neutron targets which must be inferred from measurements on deuterium. Relevant experiments are reviewed from which it is considered that: none of the approaches used to obtain neutron photoproduction cross sections in the $\Delta(1236)$ region is reliable. Nevertheless agreement within ±5% is found between first-order impulse approximation, factorization, and pole extrapolation; the neutron differential cross sections $d\sigma/d\Omega^*$ ($\gamma n \to \pi^- p$) obtained by various workers agree in the main though some variation is shown at the $\Delta(1236)$ peak, which is thought to be due to an experimental effect rather than to deuteron corrections; a majority of the results on photoproduction cross sections tends to exclude isotensor currents in $\Delta(1236)$ excitation, at the level of a few percent; the $\gamma n \to \pi^- p$ differential cross sections at $E\gamma = 350$ MeV disagree with some previous work at UCLA, assuming detailed balance. (UK)

1374 INELASTIC PHOTOPRODUCTION OF LOW MASS MUON PAIRS ON BERYLLIUM. Davis, J. F. Ithaca, NY; Cornell Univ. (1973). 173p. University Microfilms Order No. 73-31,799.

Thesis (Ph.D.).

This is a report of the yield of low mass muon pairs from a photoproduction experiment on beryllium. The incident bremsstrahlung photon beam energy went as high as 11.7 GeV. The upper limit on the invariant muon pair mass was about 600 MeV. Both muons were detected on the same side of the incident photon beam, at an angle of about 12.5°. The squared four-momentum transfer ranged from about -1.0 GeV^2 to about -5.0 GeV^2. The upper limit on the inelasticity was about 6.0 GeV. The measured inclusive cross section was much larger than that predicted by one-photon (Bethe-Heitler) processes. The Bjorken-Paschos parton model failed to account for the excess cross section. (Diss. Abstr. Int., B)

1375 DIFFERENTIAL CROSS SECTIONS FOR THE PHOTOPRODUCTION OF ETA MESONS FROM PROTONS NEAR 2 GeV. Booth, P. S. L.; Carroll, L. J.; Holt, J. R.; Jackson, J. N.; Range, W. H.; Sprakes, K. A.; Wormald, J. R. (Univ. of Liverpool). Nucl. Phys.; B71: No. 2, 211-216(1974).

Differential cross sections for the process $\gamma p \to p\eta$ were measured at c.m. angles of 28°, 35° and 42° at incident energies between 2 GeV and 2.8 GeV. Data from an earlier experiment below 2 GeV were re-analyzed and corrected. The whole set of data is compared with the form $(s-M^2)^2\, d\sigma/dt$, which fits data at higher energies. There is good agreement above 2 GeV, particularly at the largest angle, but strong departures below. (auth)

1376 POLARIZATION MEASUREMENT OF COHERENT BREMSSTRAHLUNG FROM A SINGLE CRYSTAL OF SILICON. I. Kobayashi, M.; Hiramatsu, S.; Kondo, K.; Kurokawa, S. I.; Nishikawa, T. (Tokyo Univ.). J. Phys. Soc. Jap.; 35: No. 6, 1569-1578(Dec 1973).

The linear polarization of coherent bremsstrahlung was measured by comparing one dimensionally projected angular distribution of symmetric-pair electrons with the theory. The distribution was measured with a wire chamber on both the electron and positron sides independently of each other. Polarizations obtained on both sides agreed well. The polarization was measured at 153 MeV for various orientations of the crystal. The polarization spectrum was in good agreement with the theory. A large polarization at the null injection angle of the incident electron beam to the crystal axis [110] is discussed in relation to a partial failure of the Born approximation and to the crystal dislocation. The systematic error for the polarization, temperature rise of the crystal, problems in the measuring method, etc., are discussed. (auth)

1377 OBSERVATION OF THE G-2 RESONANCE OF A STORED ELECTRON GAS USING A BOLOMETRIC TECHNIQUE. Walls, F. L.; Stein, T. S. (Univ. of Washington, Seattle). Phys. Rev. Lett.; 31: No. 16, 975-979(15 Oct 1973).

A bolometric technique is used to determine the g-factor anomaly a of the free electron from measurements made on 78°K electrons contained in a Penning-style quadrupole ion trap. The value obtained is $a = 0.001\ 159\ 667(24)$, where the electron g factor is given by $g = 2(1 + a)$. (auth)

1378 PRECISION MEASUREMENT OF THE MAGNETIC MOMENT OF THE PROTON IN UNITS OF THE NUCLEAR MAGNETON WITH HIGH VELOCITY PARTICLES. Gubler, H.; Muench, S.; Staub, H. H. (Univ., Zurich). Helv. Phys. Acta; 46: 772-791(1974).

An account is given of the investigation of the possible sources of systematic errors and the final result with increased accuracy for the measurement of the proton magnetic moment. (JFP)

Strong (Baryon-induced)

1379 NEUTRON-PROTON SCATTERING AT MEDIUM ENERGIES. Montgomery, T. C. Davis, CA; Univ. of California (1973). 79p. University Microfilms Order No. 73-32,289.

Thesis (Ph.D.).

The differential cross sections of n-p scattering were measured at 25.8, 39.7, and 50.0 MeV. The angular ranges covered were 20 to 178 degrees at 25.8 MeV, 90 to 178 degrees at 39.7 MeV, and 20 to 173 degrees at 50.0 MeV. The forward angular range was measured by using an organic scintillator as the target and detecting the scattered neutrons in an organic scintillator neutron detector in coincidence with the recoil proton in the scintillating target. The backward angular range was measured using thin

targets of polyethylene (CH_2) and detecting the recoiling charged particles with an E–DE charged particle telescope. A monochromatic neutron beam from the (p,n) reaction on ^{7}Li was selected by timing from a beam pick-off. The relative cross sections were normalized to a n-p total cross section measurement made on the same beam line. The differential cross sections are compared to various predictions and shown to be in good agreement with them. (Diss. Abstr. Int., B)

1380 MEASUREMENT OF POLARIZATION IN NEUTRON–PROTON CHARGE EXCHANGE SCATTERING FROM 2 TO 12 GeV/c. Horowitz, J. G. Columbus, OH; Ohio State Univ. (1973). 103p. University Microfilms Order No. 74-3202.

Thesis (Ph. D.).

The polarization parameter in neutron-proton charge exchange scattering in the range of incident neutron momenta 2 to 12 GeV/c and four-momentum transfer squared $.01 \leq |t| \leq 1.0$ $(GeV/c)^2$ measured in an on-line experiment performed at the Argonne National Laboratory's Zero Gradient Synchrotron. A continuous energy neutron beam was directed onto a polarized ethylene-glycol target that maintained a 40% polarization of the proton spins. The forward proton was tracked through a wire-chamber magnetic spectrometer and the recoil neutron was detected in banks of thick scintillation counters. The vector-momentum of both outgoing particles was measured allowing a three-constraint fit to be made to the events. Results are presented, based on 300,000 events, which show a negative polarization whose magnitude increases monotonically with $|t|$ 60% for $|t| \sim 0.6$ $(GeV/c)^2$ and which has little energy dependence. Comparisons are made with the predictions of models based on the t-channel exchange of π, ρ, and A_2 Reggeons. (Diss. Abstr. Int., B)

1381 ABSORPTION OF NUCLEAR AVALANCHE GENERATED BY HIGH ENERGY NUCLEONS. Keropyan, M. I.; Mamidzhanyan, E. A.; Martirosov, R. M. (Erevan Physics Inst.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 8: No. 3, 224-227(1973). (In Russian).

Nuclear-cascade avalanche formed by nucleons in an iron absorber of calorimeter in the energy region of 0.6 to 10 TeV are studied. For little depths ($X < 400$ g/cm^2) the absorption rundown of energy flow of nuclear component at the energy ~2 TeV is equal to (383 ± 36) g/cm^2. For larger depths the absorption rundown of nuclear component defined by absorption of pions at the energy of 10 GeV is equal to (130 ± 20) g/cm^2. (auth)

Strong (Meson-induced)

1382 (BUP-56) ANALYSIS OF K^+p INTERACTION BETWEEN 1.2 AND 1.7 GeV/c INCIDENT K^+ MOMENTUM. Saetre, P. (Bergen Univ. (Norway). Dept. of Physics). Oct 1973. 143p. Dep. NTIS (U. S. Sales Only) $10.25.

An exposure of K^+ mesons at four different incident momenta of the CERN 2m hydrogen bubble chamber, yielding about 75000 K^+p interactions, was analyzed. The channel $K^0p\pi^+$, dominated by the $\Delta^{++}K^0$ and K^+p quasi twobody final states, is studied in detail. This channel together with existing data on K^+p elastic scattering is used in a partial wave analysis. No evidence for a Z resonance is found. In the $K^+p\pi^+\pi^-$ channel strong associated production of the Δ^{++} and K^0 resonances is found. Their decay features are in qualitative agreement with those found at higher energies. (auth)

1383 (COO-3071-67) STRUCTURE IN THE MOMENTUM TRANSFER DISTRIBUTION OF $\pi^- + p \rightarrow \rho + N$ AT 2.3 GeV/c. Hagopian, S.; Hagopian, V.; Selove, W. (Florida State Univ., Tallahassee (USA); Pennsylvania Univ., Philadelphia (USA)). 1973. 3p. Dep. NTIS $4.00.

The data from $\pi^- + p \rightarrow \rho^0 + n$ and $\pi^- + p \rightarrow \rho^- + p$ at 2.3 GeV/c are consistent with a dip in $d\sigma/dt$ at $t \sim -0.6$ $(GeV/c)^2$ for ρ^- production and a break at $t \sim -0.6$ $(GeV/c)^2$ for ρ^0 production, in agreement with theoretical predictions and some other experiments. (auth)

1384 (DL/R-32, pp 65-73) MEASUREMENT OF THE π^- RADIATIVE CAPTURE REACTION IN THE FIRST RESONANCE REGION. Joseph, C. (Univ., Lausanne, Switzerland). 1973.

From meeting on experimental tests for exotic electromagnetic currents; Daresbury, UK (6 Jul 1973).

When considering the question of an isotensor part in the electromagnetic hadron, current additional data on the radiative capture process, especially in the energy range around the P_{33} resonance, becomes highly desirable. In the measurements reported, excitation curves between 260 and 415 MeV equivalent γ-energies for cm-γ-angles of 60, 90 and 120° were measured. Differential cross sections for π^- photoproduction, derived from π^- radiative capture measurements by detailed balance, with errors of about 10%, are tabulated. It is concluded that these measurements are consistent with the photoproduction data within the quoted experimental errors and do not show any time reversal invariance violation. (UK)

1385 (DL/R-32, pp 75-88) TEST OF TIME REVERSAL INVARIANCE IN π^-p IN EQUILIBRIUM γn. Nefkens, B. M. K. (Univ. of California, Los Angeles). 1973.

From meeting on experimental tests for exotic electromagnetic currents; Daresbury, UK (6 Jul 1973).

Final results of a measurement of the differential cross section of $\pi^-p \rightarrow \gamma n$ at centre-of-mass energies $\bar{E} = 1245$, 1337, and 1363 MeV by the UCLA-LBL Collaboration are tabulated. These final data at $\bar{E} = 1245$ MeV are 8 to 24% higher than the preliminary results due to a combination of small corrections. At the other two energies the final data give values 5% lower than the preliminary results. In addition some preliminary results of a new experiment at $\bar{E} = 1190$, 1207, 1228, 1247, and 1283 MeV by the UCLA group are included. The present results are compared with recent $\gamma n \rightarrow \pi^-p$ experiments to test time-reversal invariance. It is concluded that despite the present limit of 15% the study of $\pi^-p \rightarrow \gamma n$ is still the most sensitive test of time-reversal invariance in the electromagnetic interactions of hadrons. (UK)

1386 (INP-860) CORRELATIONS IN PARTICLE PRODUCTION IN PION–PROTON INTERACTIONS AT 40 GeV/c. Alma-Ata-Bucharest-Budapest-Cracow-Dubna-Hanoi-Moscow-Sofia-Tashkent-Tbilisi-Ulan-Bator-Warsaw Collaboration. (Institute of Nuclear Physics, Krakow (Poland)). 1973. 28p. Dep. NTIS (U. S. Sales Only) $4.50.

Results of the investigation of some correlation effects in π^-p interactions at 40 GeV/c incident momentum are given. On the basis of 2,000 events the dependence of transverse momenta of π^+ and π^- mesons on longitudinal momenta was obtained, as well as two-particle distributions for various pion pairs, and correlation functions $C(y_1,y_2)$ and $R(y_1,y_2)$. For $\pi^+\pi^-$ pairs $R(0,0) = 0.65 \pm 0.07$ and the correlation length is $L = 1.8 \pm 0.2$ for $-1 \leq y_1,y_2 \leq 1$. For $\pi^+\pi^+$ and $\pi^-\pi^-$ pairs $R(0,0) = 0.26 \pm 0.10$. Comparison of these results with proton–proton data at 200 GeV and at ISR energies suggests that limiting behavior in two-particle distributions $R(y_1,y_2)$ for π^-p interactions is already reached at 40 GeV. (auth)

1387 REACTION $K^-p \rightarrow \bar{K}^0\pi^-p$ AT 2.9 GeV/c WITH A COMPARISON TO SEVERAL VENEZIANO TYPE MODELS. Brenner, J. F. III. Medford, MA; Tufts Univ. (1973). 233p. University Microfilms Order No. 74-2033.

Thesis (Ph.D.).

The reaction $K^-p \rightarrow \bar{K}^0\pi^-p$ at 2.9 GeV/c was studied by means of a very large K^-p bubble chamber experiment. Approximately 10^6 pictures were scanned for events of topology "two prongs and a vee." After various cuts to remove scanning biases, 4408 unique events fitting the hypothesis $K^-p \rightarrow \bar{K}^0\pi^-p$ were isolated. Based on this sample, various experimental distributions were computed. These included two-body invariant mass distributions, momentum transfer squared distributions, and angular distributions of resonance decay products. As expected, the mass spectra are dominated by the $\Delta(1236)$, $K^*(890)$, and $K^*(1420)$ resonances, and the momentum transfer squared distributions show the expected peripherality. A detailed comparison was then made between the experimental distributions and the corresponding curves predicted by two Veneziano type models. One of the models contains a single free parameter and gives a good description of $K^-p \rightarrow \bar{K}^0\pi^-p$ and many of the reactions related to it by crossing symmetry and isospin invariance. The other model has six free parameters, of which five are determined by fitting to data on the reaction $K^+p \rightarrow K^0\pi^+p$ at 12 GeV/c. It is concluded that while each model has its good points, neither model is to be particularly preferred when describing $K^-p \rightarrow \bar{K}^0\pi^-p$ at 2.9 GeV/c. Using a 646 event subsample of the data, the cross section for $K^-p \rightarrow \bar{K}^0\pi^-p$ is calculated and compared with other experimental values as well as with the predictions of the models. (Diss. Abstr. Int., B)

1388 ANTIPROTON–PROTON ANNIHILATION INTO FIVE AND MORE PIONS AT 2.32 GeV/c. Oren, Y. (Argonne National Lab., IL); Cooper, W. A.; Fields, T.; Rhines, D. S.; Whitmore, J.; Allison, W. W. M. Nucl. Phys.; B71: No. 2, 189-210(1974).

High statistics data on $\bar{p}p$ annihilation into five and more pions at 2.32 GeV/c are presented. Cross sections for various final states and for the production of meson resonances were determined. The Dalitz plot asymmetry for some 4,800 ω decay events produced in $\bar{p}p \rightarrow 2\pi^+2\pi^-\pi^0$ is found to be consistent with zero. Upper limits for the production of exotic meson resonances are presented. (auth)

1389 DETERMINATION OF THE $K^-\pi^-$ INELASTIC CROSS SECTIONS FOR C.M. ENERGY UP TO 2.8 GeV. Bardadin-Otwinowska, M. (CEN, Saclay, France); Barloutaud, R.; Borg, A. Nucl. Phys.; B72: No. 1, 1-9(1974).

The reaction $K^-p \rightarrow \Delta^{++}$ + anything was studied at 14.3 GeV/c and its production mechanism was found to be consistent with one pion exchange at low momentum transfer. $K^-\pi^-$ inelastic and total cross sections have been determined by a Chew-Low extrapolation method in the c.m. energy range from threshold to 2.8 GeV. Cross sections for various $K^-\pi^-$ final states are presented. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 1130 and 1824.

1390 (COO-2220-20) NARROW RESONANCES IN STATISTICAL MECHANICS. Dashen, R. F.; Rajaraman, R. (Institute for Advanced Study, Princeton, N. J. (USA)). 1974. Contract AT(11-1)-2220. 49p. Dep. NTIS $5.50.

It is shown that when the dynamics of a system is dominated by narrow resonance formation it behaves like a noninteracting system with added species of free particles, corresponding to all the quantum numbers and the statistics of each of the resonances. This equivalence, widely assumed and used in practice, is established by explicitly constructing many particle S matrices consistent with unitarity, that correspond to purely resonance dominated dynamics. These are then used in the S matrix formulation of statistical mechanics to obtain the grand partition function, which is seen to reveal the above result. In the following operational criteria are presented for determining when in general narrow resonances and loosely bound states may be treated as "elementary" particles. (auth)

1391 (HY-TFT-73-25) QUARK QUANTUM NUMBERS IN THE CURRENT FRAGMENTATION REGION. Chaichian, M.; Cleymans, J.; Lam W. S. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1973. 10p. Dep. NTIS (U. S. Sales Only) $3.00.

The conditions are analyzed under which constituent quantum numbers can be observed in the current fragmentation region. It is assumed that quarks, isolated in phase space, undergo a cascade process thereby producing hadrons in an incoherent way. In addition to SU(3) symmetry for the produced hadrons in the current plateau, it is necessary to have a specific relation between baryon and meson production. In a simple model with short range correlations one should have, roughly, as many mesons as baryons asymptotically in the current plateau. (auth)

1392 (ITF-73-162-E) TWO-COMPONENT MODEL OF MULTIPLE PRODUCTION AND FEYNMAN GAS ANALOGY. Bogatskaya, I. G. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1973. 12p. Dep. NTIS (U. S. Sales Only) $4.00.

A variant of two-component model is proposed in the framework of gas analogy. The behavior of correlation integrals at high energies is investigated. The results obtained agree with experiment. (auth)

1393 (JINR-E2-7787) RELATIVISTIC PSEUDOPROCESSES FOR SINGLE SPINLESS PARTICLE. Garczynski, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 24p. Dep. NTIS (U. S. Sales Only) $4.25.

The two classes of stochastic pseudoprocesses are introduced and used for the construction of the Wiener pseudoprocesses with values in the Minkowski space. The solutions of the Cauchy's problems for the Schroedinger equations are constructed in the form analogous to the Feynman–Kac formula. The dependence of the Feynman path integrals on the way of construction of its finite-dimensional approximations, when an external electromagnetic field is present, is studied. The special gauge of the electromagnetic potentials is selected for which this dependence is absent. (auth)

1394 EXPONENTIAL TRANSVERSE MOMENTUM PHASE-SPACE EVENT GENERATOR. Beaupre, J. V. (Technische Hochschule, Aachen). Nucl. Phys.; B71: No. 3, 414-420(1974).

A method for generating multi-particle phase space suitable for approximately exponential $p_\perp$ matrix elements is proposed. A method of longitudinal momentum generation which allows one to easily sample the importance of certain mass combinations is also proposed. (auth)

1395 VERTEX FUNCTION AND CANONICAL LIGHT CONE SINGULARITIES. Ahmed, M. A. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim.; 20A: No. 4, 655-668(21 Apr 1974).

The canonical light-cone singularities of the vertex function are discussed with the aid of the Mellin-transformed DGS representation. It is demonstrated that these singularities correctly describe the first two terms in the asymptotic expansion of the momentum space vertex function, both in the scaling limit and in the limit in which one of the current masses goes to infinity while the second is held finite. Moreover, the coefficient function of the leading term in the latter limit is obtained as a smooth limit in the scaling variable of the corresponding function in the scaling limit. Implications for form factors are also pointed out. (auth)

1396 ISOSPIN RELATIONS OF INCLUSIVE REACTIONS. Kyriakopoulos, E. (CERN, Geneva). Nuovo Cim.; 20A: No. 4, 537-558(21 Apr 1974).

A method of obtaining isospin equalities and inequalities of cross sections and moments of the multiplicity distribution of inclusive reactions is presented. The final relations from which they are obtained do not involve Clebsch-Gordan coefficients. The linear equalities of the most interesting physically inclusive reactions are calculated. The inequalities are also briefly discussed. (auth)

1397 SOME APPLICATIONS OF ISOSPIN RELATIONS OF INCLUSIVE REACTIONS. Kyriakopoulos, E. (CERN, Geneva). Nuovo Cim.; 20A: No. 4, 559-569(21 Apr 1974).

The isospin equalities of inclusive cross sections are combined with the Mueller formalism to obtain relations of fragmentation and pionization vertices and useful simplified relations of inclusive cross sections. Isospin equalities of two-particle correlation functions are derived for particles of various isospins with the produced particles in the fragmentation region, or one in the fragmentation region and the other in the pionization region, or both in the pionization region. (auth)

1398 RECENT DEVELOPMENTS IN MATHEMATICAL PHYSICS. Proceedings of the XII International Conference on Nuclear Physics, Schladming, Austria, February 5–17, 1973. Urban, P. (Ed.). Acta Physica Austriaca, Supplementum XI. Vienna; Springer-Verlag (1973). 615p. (CONF-730227-). $57.00.

The conference included 13 papers. Separate abstracts were prepared for 12 papers. One paper as outside the subject scope of NSA. (JFP)

For abstracts of individual papers see: 1359, 1399, 1400, 1417, 1445, 1446, 1451, 1787, and 1797–1800.

1399 PARTONS IN THE LIGHT OF THE CONE. Leutwyler, H. (Univ., Bern). Acta Phys. Austr., Suppl.; 11: 117-138(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

Lectures are given on an introduction to some concepts of light cone physics. The topics covered include elastic and inelastic electron scattering, the primative parton model, and the current correlation function. (JFP)

1400 GAUGE THEORIES AND SUPERSELECTION RULES. Streater, R. (Bedford Coll., London). Acta Phys. Austr., Suppl.; 11: 317-340(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

The discussion of gauge theories and superselection rules covers the four absolutely conserved quantum numbers: charge, baryon number, lepton number, and muon number; physical representations; and nonrelativistic models. (JFP)

1401 HIGH ENERGY PHYSICS INDEX. Volume 10, 1972. Author and Affiliation Index, Preprint and Report Number Index. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 459p.

1402 APPROXIMATE SOLUTIONS OF THE LEE MODEL IN ALL SECTORS. Luchnikov, L. A. Teor. Mat. Fiz.; 19: No. 1, 76-82(Apr 1974). (In Russian).

The Källen–Pauli equation for unstable V-particles is reduced to the canonical equation, and the latter is solved approximately. The method of the solution is illustrated on the Källen–Pauli equation in the $V-\theta$ and $V-2\theta$ sectors. The method presented extends to the case of stable V-particles. The results obtained can be useful in deriving the angular distribution, energy dependence and polarization distribution of the induced radiation and in investigation of the induced decay of unstable particles. (auth)

1403 ANTIMATTER, A PROBLEM OF LOGIC AND SYMMETRY. Fridlander, E. M. Stiinta Solului; No. 11, 20-21(Nov 1973).

Antimatter is not a distinct philosophic category, nor a notion which might be opposed to matter. The existence of antiparticles,

their free behavior, and their behavior in contact with ordinary particles (annihilation) are well determined physical facts. There is an antiparticle for each known elementary particle. The particles and antiparticles develop as a result of the collisions of other elementary particles endowed with energies adequate for exceeding the energy threshold. Examples include the collision between a high energy photon and an atomic nucleus. In this context, practically all the energy of the photon is used for the development of an electron-positron pair and the endowment of these two particles with motive energy. The process occurs constantly in nature under the influence of cosmic radiation. The significance of the investigations on antimatter lies in the fact that the processes in which nucleon-antinucleon pairs develop provide ample information about the profound areas of nuclear structure. This is a factor in the development of a more effective nuclear power science. (Referativnyi Zh.)

1404 A THEORY OF ELEMENTARY COUPLINGS II. Wellner, M. (Department of Physics, Syracuse University, Syracuse, New York, 13210). Ann. Phys. (N.Y.) 76: No. 2, 549-560 (Apr 1973).

This is the second part of a work in which the compensation theory of strong interactions is described. While part I studied the leptonic decays of the pseudoscalar mesons, part II addresses itself to the quadratically divergent terms in the nonleptonic decays of the spin-half baryons. This is done in the limit of a vanishing Cabibbo angle. Some results, merely stated in part I, are derived in part II. (auth)

Electromagnetic

Refer also to abstract 1228.

1405 (AD-769483) COMPTON SCATTERING KERNEL FOR MAXWELLIAN ELECTRONS. Final Report, July 1972–April 1973. Stephen, B. G.; White, F. L.; Wilson, H. L. (Air Force Weapons Lab., Kirtland AFB, N. Mex. (USA)). Nov 1973. 43p. (AFWL-TR-73-210). NTIS $3.00.

An in-house Air Force Weapons Laboratory (AFWL) effort is documented which compiled an extensive data library describing the differential Compton scattering cross section from a relativistic Maxwellian distribution of free electrons. This report is simply a Users' Manual for using the necessary computer codes within AFWL or for locating previously generated data in the AFWL computer archives. Two codes are briefly described. The first code, TYCHO, calculates the Stone and Nelson relativistic Compton scattering kernel for 175 values of photon energies between 0.05 and 4000 keV, for any desired Maxwellian distribution of electrons described by temperature T. The second code, KEPLER, computes the first four Legendre polynomials of the differential scattering cross sections. Instructions for reading the archive tapes are given as well as user instructions for generating new data. Sample output is also included. Archive tapes include data for 18 electron temperatures from 0.25 to 20 keV. (auth)

1406 (DL/R-32, pp 43-63) NEW RESULTS ON CHARGED AND NEUTRAL PION PHOTOPRODUCTION. Littenberg, L. (Daresbury Lab., Eng.). 1973.

From meeting on experimental tests for exotic electromagnetic currents; Daresbury, UK (6 Jul 1973).

To clarify the situation concerning the possibility of the existence of exotic currents and T-violation in low energy photoproduction an experiment utilizing tagged photons was suggested. The comparison of the cross sections of the reaction $\gamma n \rightarrow \pi^0 n$ and that of $\gamma p \rightarrow \pi^0 p$ in the region of the first resonance provides a very sensitive test for the presence of an isotensor component of the electromagnetic current. The isospin couplings make the relative effect of a given isotensor amplitude twice as great as in the comparison of the charged photoproduction reactions $\gamma n \rightarrow \pi^- p / \gamma p \rightarrow \pi^+ n$. In addition, the lack of pion pole and other background to the resonance makes the comparison cleaner. (UK)

1407 (DL/R-32, pp 89-114) EXOTIC ELECTROMAGNETIC CURRENTS: PRESENT STATUS. Shaw, G. (Univ. of Manchester, Eng.). 1973.

From meeting on experimental tests for exotic electromagnetic currents; Daresbury, UK (6 Jul 1973).

Experiments designed to detect the possible existence of exotic electromagnetic currents, that is components of the current $J\mu$ which behave under symmetry transformations differently from the charge, in the reactions $\gamma + N \rightleftharpoons \pi + N$, in the energy region of the $\Delta(1236)$ resonance, are reviewed. The two possible examples of these components, namely I = 2 (isotensor) and T-violating terms are considered. The discussion of possible models begins by considering the tests for I = 2 terms on the assumption that T is conserved and the question of its possible violation is later considered. It is concluded that there is at present no evidence for T-violation in the process and that further careful study of the results considered should lead to an impressive limit on the T-violating phase. (UK)

1408 (IC-72-32) PROPERTIES OF REAL PHOTON AND PHOTON-INDUCED PSEUDOSCALAR MESON INCLUSIVE REACTION. Murai, N. (International Centre for Theoretical Physics, Trieste (Italy)). 1972. 18p. INIS.

The inclusive reaction $\gamma + p\ c + (\text{anything})$ ($c = \pi^-, K^-$) is discussed in association with the properties of the real photon. Assuming the fixed-pole behavior of the partial amplitude for $\gamma + (\text{a vector meson}) \rightarrow (\text{a meson}) + c$ at high energies in the framework of a multiperipheral model, the contribution to the structure function, integrated over the transverse momentum of c, is shown to be appreciably large, in addition to the one coming from the diagram which was expected to contribute mainly in the framework of this model. From the viewpoint of experiments it is expected from these simple calculations that the structure function at the point of the small longitudinal momentum of c in the centre-of-mass system decreases to a constant like s^{-1}, if the fixed-pole behavior exists. In the case of π^- the absolute value of the contribution is too small to tell anything definite about the properties of the real photon because even the main term, connected to the multiplicity, is smaller than the experimental value, as recently predicted. There is a possibility of obtaining information on the real photon from the photo-induced kaon inclusive reaction. This proposal is related to the validity of the multiperipheral model for the kaon reaction. (auth)

1409 VECTOR MESON PRODUCTION BY AND COMPTON SCATTERING OF POLARIZED PHOTONS OFF POLARIZED NUCLEONS. Fraas, H. (Univ., Wuerzburg, Ger.). Nucl. Phys.; B71: No. 2, 314-341(1974).

A general analysis of vector meson production by polarized photons off polarized nucleons is presented. The cross section and vector meson decay angular distribution are discussed in terms of s-channel helicity amplitudes for natural and unnatural parity exchange. For the special case of an unpolarized target the recoil polarization is also discussed. The question of experiments suitable for analyzing natural and unnatural parity exchange is investigated in detail for the case of ρ^0-production. As a special case, Compton scattering is discussed. (auth)

1410 COMMENTS ON DISPERSION THEORETIC CALCULATIONS OF MUON ANOMALOUS MAGNETIC MOMENT IN WEINBERG'S MODEL. Shizuya, K. I. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 2, 706-708(Aug 1973).

It is pointed out that the discrepancy in the calculation of the muon anomalous magnetic moment using sidewise dispersion relations in the U-gauge arises from the highly divergent nature of the U-gauge. (LBS)

1411 LIGHT-CONE EXPANSIONS, THE PARTON MODEL AND VIRTUAL $\gamma\gamma$ SCATTERING. Chernyak, V. L.; Serbo, V. G. (Inst. for Mathematics, Novosibirsk, USSR). Nucl. Phys.; B71: No. 3, 395-413(1974).

It is shown that it is sufficient to use the light-cone algebra of currents and the algebra of bilocal operators to find the asymptotic behavior of the $\gamma\gamma$ scattering amplitude when one (or two) of the photon masses $q_{1,2}^2$ is large, and for an arbitrary value of the energy squared $s = (q_1 + q_2)^2$. A general form of this asymptotic behavior is obtained. The box-diagram is dominant over the wide region in s ($\mu^2 \ll s \ll q_1^2 q_2^2/\mu^2, \mu \sim 1$ GeV) and so the asymptotic amplitude is known completely. It is shown that the parton model gives the same predictions for the asymptotic behavior of the $\gamma\gamma$ amplitude. (auth)

1412 ELECTROPRODUCTION OF π^+ MESONS IN THE SECOND AND THIRD RESONANCE REGIONS. Evangelides, E. (Univ. of Manchester, Eng.); Meaburn, R.; Allison, J.; Dickinson, B.; Ibbotson, M.; Lawson, R.; Montgomery, H. E.; Baxter, D.; Foster, F.; Hughes, G.; Kummer, P. S.; Lyth, D. H.; Siddle, R.; Devenish, R. C. E. Nucl. Phys.; B71: No. 3, 381-394(1974).

Data are presented for the reaction $ep \rightarrow en\pi^+$ at a nominal four-momentum transfer squared of 0.4 $(\text{GeV}/c)^2$. The angular distribution of the π^+ meson was measured at angles up to 70° from the virtual photon direction for isobar masses in the range 1400 → 1600 MeV/c^2 and, over a small angular range, close to the virtual photon direction for masses between 1600 MeV/c^2 and 1860 MeV/c^2. Clear evidence is seen for the presence of resonant helicity-$\frac{1}{2}$ amplitudes in both the second and third resonance regions. Some possible interpretations of the data are discussed. (auth)

1413 MODEL FOR CHARGE πN AND $\pi\Delta$ PHOTOPRODUCTION. Goldstein, G.; Owens, J. F. III. (Tufts Univ., Medford, MA). Nucl. Phys.; B71: No. 3, 461-480(1974).

A model, consisting of absorptively corrected, exchange degen-

erate π-B and ρ-A_2 Regge trajectories, is constructed for charged π-nucleon photoproduction. A fit is obtained to the existing data, and it is found that there are two significant features of the model that disagree with the data. The addition of Regge–Regge cut effects and a reduction of absorptive corrections away from the forward direction strikingly improve the fit. Using the Stodolsky–Sakurai model for $\rho N\Delta$ coupling the same improved model is applied to $\pi\Delta$ photoproduction from deuterons. Excellent agreement is obtained with the existing data. (auth)

1414 QUANTUM MODEL OF PHOTODETECTION. Rocca, F. (Univ., Nice). Phys. Rev., D; 8: No. 12, 4403-4410(15 Dec 1973).

The probability $P^{(n)}(t_0,t)$ of counting n photoelectrons during any time interval $[t_0,t]$ in a photodetection model built in the general framework of quantum field theory is considered. Owing to an equilibrium assumption on the detector state, $P^{(n)}(t_0,t)$ is evaluated from the incident field and some electron-correlation functions. The conditions for $P^{(n)}(t_0,t)$ to be a compound Poisson distribution as expected are discussed. This leads to the definition of coherence properties for the electrons of the detector in connection with the reliability of the detection operation in counting experiments. (auth)

1415 SINGLE PHOTON EMISSION IN ELECTRON–POSITRON COLLIDING BEAM REACTION $e^+e^- \to \mu^+\mu^-$. Hayashi, M. (Saitama Medical Coll., Kawakado, Japan). Acta Phys. Pol.; B5: No. 2, 167-177(1974).

The energy spectrum of the photons emitted in the reaction $e^+e^- \to \mu^+\mu^-\gamma$, and the hard photon correction to the total cross section of the reaction $e^+e^- \to \mu^+\mu^-$ are evaluated. A simple technique is developed based on the analytical QED formulae, in particular, on the current conservation. (auth)

1416 SOME PROPERTIES OF FORM FACTORS WITH NON-NEGATIVE IMAGINARY PARTS. Mickens, R. E. (Fisk Univ., Nashville). Acta Phys. Pol.; B5: No. 2, 179-181(1974).

Considered are properties of the form factor F(t) which follow from the assumptions that F(t) satisfies an unsubtracted dispersion relation and its imaginary part is non-negative for $t \geq t_0$. (auth)

1417 INFRARED PROBLEM IN ELECTRON SCATTERING. Steinmann, O. (Schweizerisches Institut fuer Nuklearforschung, Villigen). Acta Phys. Austr., Suppl.; 11: 167-198(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

Lectures are given on the problem of a new approach to the field theoretic description of electron scattering. The scattering events are considered as events taking place in space–time studied with the help of localized detectors. (JFP)

1418 PHENOMENOLOGICAL ANALYSIS OF CHARGED π NUCLEON AND $\pi\Delta$ PHOTOPRODUCTION AT HIGH ENERGIES. Owens, J. F. III. Medford, MA; Tufts Univ. (1973). 203p. University Microfilms Order No. 74-2046.

Thesis (Ph. D.).

Initially, a model consisting of exchange degenerate π-B and ρ-A_2 Regge poles plus their absorptively generated cuts is applied to charged π nucleon photoproduction. The inadequacies of the model are noted and a multi-parameter analysis is performed which isolates the additional terms needed to correct the model. The inclusion of Regge-Regge cut effects is found to improve the agreement between the model and the data. Further improvement is obtained if the size of the absorptive corrections is reduced away from the forward direction thereby reducing the pole-cut interference. A similar analysis is performed for $\pi\Delta$ photoproduction from deuterium. The addition of Regge-Regge cut effects and the modification of the absorptive corrections results in excellent agreement between the model and the existing data for the differential cross sections and the polarized photon asymmetries. (Diss. Abstr. Int., B)

1419 MULTIPLE SCATTERING OF CHARGED PARTICLES IN IRREGULAR MAGNETIC FIELDS. Thielheim, K. O. (Univ., Kiel). J. Phys., A (London); 7: No. 3, 444-448(11 Feb 1974).

Charged particle propagation in irregular magnetic fields is investigated. Multiple small angle scattering is considered in a model field configuration. The irregular magnetic field components are specified by their energy density and autocorrelation function. The mean deviation from ideal particle direction is given explicitly. A diffusion equation with variable diffusion coefficient is established, ordinary diffusion theory is found to be valid asymptotically. Results are applied for an estimation on the range of validity of the single-particle approach to the propagation of primary cosmic ray particles at extremely high energies. (auth)

1420 AUTOMODEL BEHAVIOR OF THE VIRTUAL COMPTON SCATTERING AMPLITUDE IN THE FRAMEWORK OF THE DYSON–JOST–LEHMANN REPRESENTATION. Wieczorek, E.; Matveev, V. A.; Robaschik, D. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 19: No. 1, 14-26(Apr 1974). (In Russian).

Using the Dyson–Jost–Lehmann representation for one-particle matrix elements of the T-product of electromagnetic currents, the automodel behavior of the virtual Compton scattering amplitude and the corresponding light cone singularities of the T-product are studied. Pecularities connected with logarithmic contributions are investigated. (auth)

1421 HEAVISIDE RADIATION. Kaiser, T. R. (Univ. of Sheffield, Eng.). Nature (London); 247: No. 5440, 400-401(8 Feb 1974).

It is well known that a charged particle, moving through a refracting medium at a speed in excess of the phase velocity of electromagnetic waves, produces radiation. This effect is observable with energetic electrons in water and other media, with cosmic ray particles moving through the atmosphere, and may also be a source of very low frequency radio waves in the ionosphere and magnetosphere; its discovery is usually attributed to Cerenkov and its theoretical interpretation to Frank and Tamm. An extract concerning the effect is reproduced, and it is considered that the name of Heaviside should be associated with it. (UK)

1422 AXIAL VECTOR MESON PHOTOPRODUCTION AT HIGH ENERGIES. Akopov, N. Z.; Zverev, A. M.; Matinyan, S. G.; Shakhnazaryan, Yu. G. (Erevan Physics Inst.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 8: No. 3, 161-167(1973). (In Russian).

The photoproduction of A_1-and B-mesons on nucleons is considered on the basis of the absorption model. The t-dependencies of the differential cross section, the asymmetry connected with the linear polarization of photons and the parity asymmetry at various energies are obtained. (auth)

Weak

1423 NEUTRINO SPECTRUM AND THE ORIGIN OF THE CABIBBO ANGLE. Pakvasa, S. (Univ. of Hawaii, Honolulu); Tennakone, K. Lett. Nuovo Cim.; 9: No. 14, 565-569(6 Apr 1974).

A possible existence of an infinite series of neutrinos whose properties are completely specified by a universal quantum number was previously suggested. It is suggested that out of the entire family of neutrinos, different subsets are associated with $\Delta S = 0$ processes and with $\Delta S = 1$ processes. It is shown that in such a scheme, even if the $\Delta S = 0$ and $\Delta S = 1$ hadronic currents couple with equal strength, suppression of $\Delta S = 1$ semileptonic decay rates with respect to $\Delta S = 0$ rates is possible. Observable consequences of this explanation of Cabibbo angle are discussed. (LBS)

1424 NEUTRINO CHARGE RADIUS. Bardin, D. Yu.; Mogilevskii, O. A. (Joint Inst. of Nuclear Research, Dubna, USSR). Lett. Nuovo Cim.; 9: No. 14, 549-553(6 Apr 1974).

Strong constraints on the mean squared radii of the electron and muon neutrinos are obtained by analyzing recent experiments on hadron production in deep inelastic neutrino and antineutrino interactions with nucleons. (LBS)

1425 NEUTRINO–LEPTON SCATTERING AND LEPTON CONSERVATION LAWS. Tsai, S. Y. (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 50: No. 2, 710-712(Aug 1973).

The construction of a phenomenological model of weak interactions is considered, which implies the existence of an additive conservation law of muon member (N_μ) and thus allows one to correlate $\Delta N_\mu = \pm 2$ transitions to $\Delta N_\mu = 0$ ones. A simple example of such models is proposed and its implications on neutrino-lepton scattering are investigated. (LBS)

1426 ULTRA-RELATIVISTIC NEUTRINO GAS IN COSMOLOGY. Novello, M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 21: No. 3, 35-50(1973).

A neutrino field self-interacting through Heisenberg's fundamental equation is considered. It is shown that it is possible to have a situation in which the neutrino field behaves as an ultra-relativistic gas. (auth)

1427 LEPTON NUMBER LAW: ADDITIVE OR MULTIPLICATIVE. von Krogh, J. (Technische Hochschule, Aachen); Rodenberg, R. Notas Fis., Cent. Brasil. Pesqui. Fis.; 21: No. 1, 1-15(1973).

A short review of the lepton number conservation law is given. After a discussion of past experimental tests a tentative analysis is presented in which a distinction can be made between an additive and multiplicative lepton number law. (auth)

1428 OCTET ENHANCEMENT IN A RENORMALIZABLE WEAK-INTERACTION MODEL. Isgur, N. (Univ. of Toronto). Nuovo Cim.; 20A: No. 4, 585-594(21 Apr 1974).

Finite one-loop graphs which arise in a recently proposed renormalizable scalar-boson theory of the weak interaction are shown to lead to a mechanism for octet enhancement of $\Delta Y = 1$ hadronic processes. (auth)

1429 ANALYSIS OF THE NEUTRINO ELASTIC ($\nu + n \rightarrow p + \mu^-$) EVENTS. Yoshiki, H. (National Lab. for High Energy Physics, Oho, Japan). Helv. Phys. Acta; 46: 792-806(1974).

An enhancement in μp mass-spectrum at 1.8 to 2.0 GeV/c^2 mass region from the elastic neutrino reaction, $\nu + n \rightarrow p + \mu^-$, is discussed. The observation is based on the CERN neutrino experiments from 1963 to 1967 using the CERN Heavy Liquid Bubble Chamber. (auth)

1430 REVIEW OF THE $K_L \rightarrow \mu^+\mu^-$ PUZZLE. Stern, H. (Service de Physique théorique, Centre d'Etudes Nucléaires de Saclay, BP n° 2, 91, Gif-sur-Yvette, France); Gaillard, M.K. Ann. Phys. (N.Y.) 76: No. 2, 580-606 (Apr 1973).

It is recalled that the conventional mechanisms for weak and electromagnetic interactions and for observed particles lead via, unitarity and CPT, to a predicted value for the branching ratio of $K_L \rightarrow \mu^+\mu^-$ in contradiction with the experimental upper limit. We review the models suggested as a solution to this puzzle which introduce new particles and/or new interactions; the models which preserve CP invariance appear unattractive or seem dubious from the experimental point of view; the models which incorporate large CP violations, predict an anomalously large value for the ($K_S \rightarrow \mu^+\mu^-$) -branching ratio which requires experimental confirmation. (auth)

1431 NONLOCAL THEORY OF THE ELECTROMAGNETIC AND WEAK INTERACTIONS WITH W-BOSON. Alebastrov, V.A.; Efimov, G.V.; Seltzer, Sh.Z. (Joint Institute for Nuclear Research, Laboratory of Theoretical Physics, Dubna, U.S.S.R.). Ann. Phys. (N.Y.) 76: No. 1, 251-280 (Mar 1973).

The perturbation theory of the electromagnetic and weak interactions is considered in the framework of nonlocal theory. A hypothesis is proposed that the photon and neutrino fields are connected with the charged local fields of the electrons, muons, and W bosons in the nonlocal way. The definite intermediate regularization procedure is introduced that the S matrix is finite, unitary, causal, gauge invariant in perturbation theory when regularization is moved off. The interaction Lagrangian contains no infinte counter terms and the S matrix is finite without any infinite renormalizations. (auth)

1432 DISCOVERY OF NEUTRAL CURRENTS. Borisov, L. Usp. Fiz. Nauk; 111: No. 4, 743-744(Dec 1973). (In Russian).

Literature data on the detection of neutral currents in weak interactions are summarized. The model proposed for neutral currents is outlined. (JSR)

Strong (General)

1433 (IFVE-STF-73-79) ANALYTICAL PROPERTIES OF SCATTERING AMPLITUDE IN THE STRONG COUPLING THEORY. Semenov, S. V.; Timofeevskaya, O. D.; Tyurin, N. E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1973. 12p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

The system of two nonrelativistic particles and quantum scalar field is considered. In assumption of strong coupling between particles and field the interaction potential is smooth and tends to Yukawa's potential at $r \rightarrow \infty$. The analytical properties of scattering amplitude are studied, and the amplitude at small (in comparison with energy) momentum transfers is estimated. (auth)

1434 LARGE-TRANSVERSE-MOMENTUM PARTICLES IN A PHENOMENOLOGICAL TWO-COMPONENT MODEL. Jabs, A. (Univ. Trier-Kaiserslautern, Kaiserslauten, Ger.). Lett. Nuovo Cim.; 9: No. 14, 570-574(6 Apr 1974).

An explanation of the unexpectedly high yield of large-transverse-momentum particles from recent CERN intersecting storage ring data above 2 GeV/c is given in terms of a phenomenological two-component model. The basic kinematical features governing the large-transverse-momentum behavior are then discussed. (LBS)

1435 PERTURBATIVE APPROACH TO THE POMERON. I. The Multifireball Expansion. Bishari, M.; Chew, G. F.; Koplik, J. (Univ. of California, Berkeley). Nucl. Phys.; B72: No. 1, 61-92(1974).

A perturbative S-matrix description of the pomeron motivated by the two-component model of multiparticle production is presented. The latter is taken as a first approximation and corrections are generated by repeated pomeron exchange. Each term in the expansion is associated with a well-defined class of scattering processes, and the convergence properties are related to the smallness of pomeron couplings. The basic ideas, a general formalism, and the interrelationship of various Regge singularities are emphasized. A following-paper discusses a simplified model in more detail. (auth)

1436 PERTURBATIVE APPROACH TO THE POMERON. II. A Simple Model. Bishari, M.; Koplik, J. (Univ. of California, Berkeley). Nucl. Phys.; B72: No. 1, 93-110(1974).

The perturbative approach to the pomeron via the multifireball expansion proposed in the preceding paper is further analyzed in the context of a simplified model. A detailed picture of the pomeron is given, with special attention paid to the extent of factorization and the strength of the output two-pomeron cut. The role of various production mechanisms in building the output singularities is clearly exhibited. The energy dependence of total cross sections is discussed in the framework of the perturbative series and compared to the complementary interpretation in terms of output Regge poles. The possibility of a rising total cross section is carefully examined. (auth)

1437 SELF-CONSISTENT DIFFRACTION IN THE MULTIPERIPHERAL MODEL. II. Ball, J. S. (Univ. of Utah, Salt Lake City); Zachariasen, F. Nucl. Phys.; B72: No. 1, 149-166(1974).

A self-consistent solution to a multi-peripheral model in which the triple pomeron vertex vanishes is presented. This solution possesses all of the good features of a previous model, having naturally diffractive and multiperipheral terms in the total cross section and in particle production. In addition, its region of validity has been increased to include the normal Regge region and a smooth transition from Regge-like behavior to the diffractive limit is obtained. (auth)

1438 SPIN CONSTRAINTS ON THE PARTICLE SPECTRUM IN A DUALITY BOOTSTRAP. Mandula, J. E. (Massachusetts Inst. of Tech., Cambridge); Weyers, J.; Zweig, G. Nucl. Phys.; B71: No. 3, 365-380(1974).

The constraints on the particle spectrum following from the requirement that sums of resonances yield the spin structure of the leading exchange are discussed. (auth)

1439 RESCATTERING CORRECTIONS AND THE TRIPLE-POMERON COUPLING. Ciafaloni, M. (CERN, Geneva); Marchesini, G. Nucl. Phys.; B71: No. 3, 493-513(1974).

The asymptotic consistency of an $\alpha = 1$ pomeron pole with a non-vanishing triple-pomeron coupling $g_P(0)$ is re-examined in connection with absorptive corrections to diffractive production. An absorptive multiperipheral model is presented in which elastic rescattering among pairs of particles produced in the final state is included. In this way the contribution of enhanced many-pomeron cuts to the inclusive distribution $d\sigma/dx$ close to $x = 1$ is calculated, and it is shown that the over-all contribution integrates to a factorized constant. It is concluded on this basis that s-channel iteration modifies in an important way t-channel arguments and could possibly explain why $\alpha = 1$ asymptotically. (auth)

1440 DO ELECTROMAGNETIC FORM FACTORS AND DEEP ELASTIC SCATTERING MEASURE THE NUMBER OF QUARKS IN A HADRON. Close, F. E. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Nucl. Phys.; B71: No. 2, 217-225(1974).

By studying field theory examples the claim that dimensional arguments relate the q^2 dependence of electromagnetic form factors and the s-dependence of large-angle scattering to the number of constituents in the systems involved is examined. The relationship with various models in the literature is discussed. (auth)

1441 RELATIVISTIC THREE-PARTICLE PROBLEM AND HEAVY QUARKS. Meyer, R. F. (Deutsches Electronen-Synchrotron, Hamburg). Nucl. Phys.; B71: No. 2, 226-240(1974).

Strong binding of three scalar quarks is investigated in the framework of Bethe–Salpeter equations. After starting the relevant field-theoretic formulae, possible dynamical assumptions are discussed which can help to describe the observed baryon mass spectrum. Just as in the quark-antiquark case a covariant harmonic oscillator approximation may be formulated, and it is shown that this corresponds to linear Regge trajectories. The resulting Bethe–Salpeter amplitude of the ground state is used in a calculation of the electromagnetic radius by means of the triangle graph model. The oscillator constant as obtained by matching the Regge slope leads, independently of the quark mass, to 0.8 fm for the e.m. radius. (auth)

1442 SOME CONSIDERATIONS CONCERNING THE COHERENT DROPLET MODEL OF HIGH ENERGY HADRON–HADRON

SCATTERING. Rosendorff, S. (Technion-Israel Inst. of Tech., Haifa). Nuovo Cim.; 20A: No. 4, 613-646(21 Apr 1974).

It is shown that in the framework of the coherent droplet model the differential cross section of the elastic scattering of two hadrons is not necessarily proportional to the square of the product of the hadronic matter form factors when $q \to \infty$, q being the momentum transfer. Examples are given to prove—contrary to assumptions made in the literature—that the rapid decrease of the spectral weight function, when $q \to \infty$, does not secure the above relationship between cross section and form factors. It is the effective interaction which determines uniquely the behavior of the cross section as a function of momentum transfer and strength of interaction: (i) Interactions with a cusplike or logarithmic singularity at the origin give rise to differential cross sections which are proportional to the square of the strength of the interaction as well as to the product of the form factors. In this case the cross section behaves like some power of $1/q$, when $q \to \infty$. (ii) Interactions which are smooth at the origin, in other words expandable in ascending powers of r^2 about the origin, give rise to cross sections which are not related in any simple way to the square of the product of the form factors. In this case the cross section decreases faster than any power of q. In both (i) and (ii) it is possible to construct rapidly decreasing, as well as nondecreasing, spectral weight functions, when $q \to \infty$. (auth)

1443 MASS DEPENDENCE OF THE SLOPES: COMPARISON OF DIFFERENT PARAMETRIZATIONS, OBSERVATION OF REGULARITIES IN THE DATA. Gula, A. (Inst. of Nuclear Tech., Krakow). Acta Phys. Pol.; B5: No. 2, 209-228(1974).

The mass dependence of the slopes in hadronic production processes is analysed. Different parametrizations of the data are compared. A parametrization is found which describes very well the data for processes of different kinds (exclusive: diffractive and non-diffractive, and inclusive) and which exhibits some interesting regularities in the data. In particular the slopes in production processes at large invariant masses of the produced system of particles are related to the slopes in two-body and quasi-two body reactions. The slopes for meson resonances produced in nondiffractive processes are found to deviate from a smooth slope-versus-mass dependence of the background in a way depending on the Q-value of the resonance. (auth)

1444 ELECTROMAGNETIC THEORY OF STRONG INTERACTION. Bergstroem, A. (Research Inst. of National Defense, Stockholm). Phys. Rev., D; 8: No. 12, 4394-4402(15 Dec 1973).

From dielectric-diamagnetic properties shown to be inherent in the electromagnetic interaction itself by its very nature, and the fact that the dielectric attraction effect in a charged dielectric medium may dominate over the pure Coulomb repulsion, a hypothetical mechanism, which under special circumstances seems to be able to hold a charged object together, is presented, the diamagnetic property making the mechanism independent of the velocity of the object. This approach is shown to give a Yukawa-type equation for the electromagnetic field within a charged medium, and leads to a tentative electromagnetic interpretation of strong interaction analogous to the theory of plasmons. In addition to the prediction of the pion mass from the nuclear interaction range as in the Yukawa theory, the electromagnetic approach also predicts the existence of a lighter stable structure with a mass which agrees in order of magnitude with the mass of the electron, and suggests the existence of an excited state of this structure with a mass which agrees with the mass of the muon. On a macroscopic scale, the hypothetical charge-confinement mechanism presented gives energy contents for ball lightning which are of the same order of magnitude as the extremely high values ($\approx 10^7$ J) reported for this phenomenon. (auth)

1445 DYNAMICAL PROBLEMS OF THE RELATIVISTIC QUARK MODEL. Boehm, M. (Univ., Wuerzburg, Ger.); Joos, H.; Krammer, M. Acta Phys. Austr., Suppl.; 11: 3-116(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

The specific dynamical problems arising in the formulation of the relativistic quark model in the framework of field theory are considered. Hadron dynamics, mesons as quark–antiquark bound states, the fermion–antifermion Bethe–Salpeter equation, and phenomenological applications are treated. (JFP)

1446 MAGNETIC CHARGES AND STRINGS AS BUILDING BLOCKS OF HADRONS: CONNECTION BETWEEN ELECTROMAGNETIC AND DUAL STRINGS. Barut, A. O. (International Centre for Theoretical Physics, Trieste, Italy). Acta Phys. Austr., Suppl.; 11: 565-595(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

The close mathematical and physical connections of the infinite multiplets and magnetic charges to the spectrum of the dual models, to the underlying string models, and to saturation of current algebras is pointed out. It is shown how one can obtain, starting from a very simple physical model involving magnetic charges, the internal dynamical properties of hadrons, in particular of the proton, such as the form factors (elastic and inelastic), mass spectra, and inelastic structure functions. The results on the physics of magnetic charges include the electromagnetic origin of spin, parity, and superselection rule, group structure and exact solutions, and the string between the magnetic charges. (JFP)

Strong (Baryon No. = 0)

Refer also to abstract 1495.

1447 (HU-TFT-73-30) ZEROES OF THE PION FORM FACTOR. Cronstroem, C. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Nov 1973. 13p. Dep. NTIS (U. S. Sales Only) $4.00.

A sum rule for the modules of the pion form factor in the time-like region is derived, by means of which the existence of complex zeroes in the form factor can be tested. The available data indicates that such zeroes exist. (auth)

1448 (JINR-E2-7801) BEST X^0 (958)-MESON SPIN ANALYZER. Lednitski, R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1974. 16p. Dep. NTIS (U. S. Sales Only) $4.00.

From QD;

The X^0(958) production and decay correlations are discussed. The question of the best X^0 -meson spin analyzer is studied. (auth)

1449 RADIATION OF GLUON WITH EXPECTED MASS OF 500 MeV AND EXPECTED LARGE BRANCHING RATIO OF $\rho \to \pi\pi^0\gamma$ AND $B \to \pi\pi^0\gamma$. Baba, Y. (Kanazawa Univ., Japan); Matumoto, K. I. Progr. Theor. Phys. (Kyoto); 50: No. 5, 1752-1753 (Nov 1973).

A hypothesis was previously proposed, in order to explain the surprisingly large branching ratio of $\eta \to \pi^0\gamma\gamma$ decay, in which there exists a new kind of isoscalar-vector-boson U with mass smaller than m_η and $\eta \to \pi^0\gamma\gamma$ proceeds as $\eta \to \gamma + U \to \gamma + (\gamma + \pi^0)$. It is shown that a large branching ratio is expected also in $\rho \to (\pi U) \to \pi\pi^0\gamma$ and $B \to (\pi U) \to \pi\pi^0\gamma$ decay and that the experimental knowledge will enable one to test the hypothesis. (LBS)

1450 I. BARYON–ANTIBARYON PHASE TRANSITION AT HIGH TEMPERATURE. II. INCLUSIVE VIRTUAL PHOTON–HADRON REACTIONS IN THE PARTON MODEL. Cisneros, A. Pasadena, CA; California Inst. of Tech. (1973). 80p. University Microfilms Order No. 73-31,037.

Thesis (Ph. D.).

Present experimental data on nucleon-antinucleon scattering allow a study of the possibility of a phase transition in a nucleon-antinucleon gas at high temperature. Estimates can be made of the general behavior of the elastic phase shifts without resorting to theoretical derivation. A phase transition which separates nucleons from antinucleons is found at about 280 MeV in the approximation of the second virial coefficient to the free energy of the gas. The parton model is used to derive scaling laws for the hadrons observed in deep inelastic electron–nucleon scattering which lie in the fragmentation region of the virtual photon. Scaling relations are obtained in the Bjorken and Regge regions. It is proposed that the distribution functions become independent of both q^2 and ν where the Bjorken and Regge regions overlap. The quark density functions are discussed in the limit $x \to 1$ for the nucleon octet and the pseudoscalar mesons. Under certain plausible assumptions it is found that only one or two quarks of the six types of quarks and antiquarks have an appreciable density function in the limit $x \to 1$. This has implications for the quark fragmentation functions near the large momentum boundary of their fragmentation region. These results are used to propose a method of measuring the proton and neutron quark density functions for all x by making measurements on inclusively produced hadrons in electroproduction only. Implications are also discussed for the hadrons produced in electron–positron annihilation. (Diss. Abstr. Int., B)

1451 CHIRAL INVARIANCE AND LOW ENERGY PION–PION SCATTERING. Lehmann, H. (Univ., Hamburg). Acta Phys. Austr., Suppl.; 11: 139-166(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

The lectures on the consequences of chiral invariance for low

energy pion–pion scattering are described. These include a formulation of chiral invariance in the context of general quantum field theory and from it the derivation of the Adler–Weinberg theorem for $\pi\pi$ scattering, the extension of this theorem to higher pion momenta and its application to the scattering phase shifts in an effective range approximation, and attempts to obtain further information on $\pi\pi$ scattering by making dynamical assumptions beyond chiral invariance and treating a Lagrangian field-theoretical model for the interaction of pions and nucleons in the one-loop approximation. (JFP)

1452 ELECTROMAGNETIC FORM FACTORS AND K–π SCATTERING. Curry, P. H. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis (Ph. D.).

The theoretical aspects of pion and nucleon form factors are discussed. A phenomenological model is developed and found to be consistent with $F_1^V = F_\pi$. A model proposed by J. W. Moffat for k–π and π–π scattering is described. This model is shown to satisfy the postulates of S-matrix theory, except for unitarity, and is found to be in reasonable agreement with experiment. (Diss. Abstr. Int., B)

1453 THEORY OF LOW-ENERGY $\pi\pi$ SCATTERING. Carrotte, J.B.; Johnson, R.C. (Department of Mathematics, Durham University, U.K.). Ann. Phys. (N.Y.) 76: No. 1, 116-136 (Mar 1973).

A four-parameter family of solutions to the $\pi\pi$ partial-wave dispersion relations is obtained using the inverse amplitude method. Choosing the parameters consistent with phenomenological values and so as to maximize agreement with rigorous sum rules and inequalities leads to a firm prediction of the phase shifts for S and P wave scattering and for the amplitudes below threshold. Neglecting inelasticity, the I=0 S-wave resonates near $\sqrt{s}$=540 MeV, the I=2 S-wave falls to about -12° near 1 GeV, and the P-wave is ρ-dominated. The S-waves have subthreshold zeroes consistent with the Adler condition. Inelastic effects are estimated and found to be small below the rho meson mass. (auth)

Strong (Baryon No. = 1)

1454 (DESY-74-1) NEW FORM OF VECTOR MESON DOMINANCE AND THE DEPENDENCE ON THE VECTOR MESON MASS SQUARED. Iso, C.; Iwai, S.; Kanasugi, H.; Miyata, Y. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F. R. Germany)). Jan 1974. 24p. Dep. NTIS (U. S. Sales Only) $4.25.

A new form of VMD which relates the reactions $\pi N \to \bar{V}N$ and "γ" $N \to \pi N$ is proposed. The form fits the experimental results within errors. As the restriction is strong enough, one can discuss the k_μ^2-dependence. Unexpectedly the k_μ^2-dependence is larger, and this may suggest the necessity of generalized vector dominance. (auth)

1455 (HU-TFT-73-26) NEW PHENOMENA IN $\pi N \to \pi N$: SATURATION OF THE MOST STRINGENT ISOSPIN BOUND. Toernqvist, N. A. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Oct 1973. 13p. Dep. NTIS (U. S. Sales Only) $3.00.

The most stringent isospin bound for $\pi N \to \pi N$ must be saturated along certain lines in the s–t plane. These lines correspond to zeros of the imaginary part of a bilinear combination of the amplitudes and impose strong constraints on data and amplitude analyses. For $t \leq -1$ GeV/c the bound is always nearly saturated for the energies in the energy region below 2 GeV/c where this analysis was done. (auth)

1456 (HU-TFT-73-31) SPECULATIONS ON QUARK STRUCTURE AND COUPLINGS. Raitio, R. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Nov 1973. 7p. Dep. NTIS (U. S. Sales Only) $4.00.

The resonances $N^*(1470)$, $N^*(1780)$ and $\rho'(1600)$ are studied. The constituent quark model is supplemented by two requirements: consistency with current algebra relations and a quark-hadron bootstrap. (JPL)

1457 (IFVE-STF-73-59) GROWTH OF TOTAL CROSS SECTIONS AND THE SLOPE OF THE DIFFRACTION CONE. Solov'ev, L. D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1973. 6p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

The increase of the total K^+p-cross section discovered at Serpukhov and the fast growth of the pp-cross section recently observed at CERN ISR may be of the same physical nature, namely, they can obey a universal Froissart mechanism. The observed behavior of the diffraction cone slope does not contradict this mechanism. A rapid rise of the K^+p-cross section at Batavia follows from this suggestion. (auth)

1458 (ITF-73-175-E) DAMA FOR MESON–BARYON SCATTERING. Enkovskii, L. L.; Kobylinskii, N. A.; Prognimak, A. B. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1973. 28p. Dep. NTIS (U. S. Sales Only) $4.50.

The generalization of DAMA (dual amplitude with Madelstam analyticity) to the case of meson-baryon scattering is studied. To this end trajectories with left-hand cut are introduced in the model under consideration. Threshold and asymptotic bounds on these trajectories are obtained. Combinations suitable for boson-fermion and fermion-fermion amplitude are constructed. A specific example, namely πN-scattering, is considered, for which dual models of invariant amplitudes are built up. (auth)

1459 (JINR-E2-7732) ISOSPIN BOUNDS ON POLARIZATION AND SPIN ROTATION PARAMETERS. Ion, D. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 20p. Dep. NTIS (U. S. Sales Only) $4.00.

All the isospin constraints on polarization P and spin rotation A,R parameters are derived using the bilinear forms defined with the scattering amplitudes of two $(0\ 1/2 \to 0'\ 1/2')$ reactions related by isospin invariance. The saturation of the isospin bounds is investigated. (auth)

1460 DUALITY AND REGGE–MUELLER PHENOMENOLOGY FOR INCLUSIVE SPECTRA. Freeman, J. R. (Univ. of Washington, Seattle). Nucl. Phys.; B71: No. 2, 301-313(1974).

Further predictions are examined of a recently proposed, phenomenologically supported, duality scheme for double Regge–Mueller graphs. It is stressed that these duality constraints should be tested, not only on the non-scaling behavior at $x = 0$ of single-particle spectra, but also on the shape (i.e. curvature) of rapidity spectra. Exchange degeneracy constraints for single and double Regge–Mueller expansions are used, together with factorization to investigate two-particle spectra of $(a \to d|c|b)$ when one particle is near the kinematic boundary and the other is in the central region. A rapid scaling criterion is derived. The relative sizes of the non-scaling part of $(p \to \pi^-|c|b)$ spectra c = π^+, π^-, π^0, b = π^+, π^-, K^+, K^-, p are estimated. An extended pattern of duality constraints for many particle Regge–Mueller graphs is suggested. (auth)

1461 INDIRECT EVIDENCE FOR THE EXISTENCE OF PARTICLES OF FRACTIONAL BARYON NUMBER. Burt, P. B. (Clemson Univ., SC). Progr. Theor. Phys. (Kyoto); 50: No. 3, 1091-1092(Sep 1973).

It is pointed out that the well-established relation between nuclear radii and mass number (or total number of baryons) can be used, in combination with a model of mesons, to deduce a root-mean-square baryon charge of a meson less than unity. It is thus suggested that a model can be constructed to imply the existence of particles with baryon number less than unity. (LBS)

1462 SPECTATOR ASSUMPTION IN URBARYON REARRANGEMENT REACTIONS. Ghoroku, K. (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 50: No. 3, 1089-1090 (Sep 1973).

A counting scheme of the urbaryon rearrangement diagram is examined by taking account of spin flip of the urbaryon. A relation between F_+ and F_- is derived by introducing the effect of helicity flip for spectators, where $F_\pm \equiv f_\pm (f_\pm + d_\pm)$ is the f/d ratio of the helicity nonflip and flip amplitudes in the s-channel. It is concluded that the spectator assumption is correct as the first-order approximation but small amount of helicity flip is necessary. (LBS)

1463 BARYON SPECTROSCOPY AND THE QUARK SHELL MODEL. II. Numerical Fitting to the Data and the Baryonic Predictions. Horgan, R. (Oxford Univ.). Nucl. Phys.; B71: No. 3, 514-545(1974).

A shell-model description for a three-quark bound state is used with harmonic-oscillator quark–quark interactions. The baryon spectrum is associated with the energy levels of such a system which is taken to exhibit a broken $SU(6)_O \otimes O(3)$ symmetry. In an earlier paper, baryon states were constructed in the $SU(3) \otimes SU(2)_S \otimes O(3)$ basis of this scheme, and a symmetry-breaking mass operator was defined as being a linear combination of two-body tensor operators, each of which has a definite transformation property under $SU(6) \otimes O(3)$. The matrix elements for each tensor operator were given when acting on the states associated with the N = 0, 1 and 2 harmonic-excitation bands of the model. In this paper, the eigenvalues in the mass-operator expansion are obtained by a least-squares fit of experimental data to the eigenvalues of the mass operator for each multiplet belonging to these excitation bands. The multiplets considered are $(56,0^+)_0$, $(70,1^-)_1$, $(56,2^+)_2$, $(70,2^+)_2$, $(20,1^+)_2$, $(56,0^+)_2$ and $(70,0^+)_2$. Constraints between the parameters associated with different multiplets previously derived are imposed in order to greatly reduce the

number of available solutions. The results give assignments for known baryons and predict those required to complete the multiplets. It is found that no mixing is possible among the nucleon states of the $(70,1^-)_1$ and that none is predicted among the non-strange states of the N = 2 excitation band. The established resonances pertinent to these multiplets are well accommodated in our scheme and the prediction of $\Sigma D_{11}(1470)$ is given. The full predicted spectra are given. (auth)

1464 BARYON EXCHANGE AND URBARYON REARRANGEMENT DIAGRAM. Toyoda, F. (Kinki Univ., Osaka). Progr. Theor. Phys. (Kyoto); 50: No. 2, 702-703(Aug 1973).

An analysis is made of the urbaryon rearrangement diagram amplitudes for the baryon exchange processes $K^+p \rightarrow pK^+$, $K^-p \rightarrow \Xi^-K^+$, and $\pi^+p \rightarrow p\pi^+$. Good agreement is found with experimental data. (LBS)

1465 A_1-CONTRIBUTION TO THE DIFFERENTIAL CROSS SECTION $\rho\frac{1}{10}d\sigma/dt$ OF REACTION $\pi^+ + p \rightarrow \rho^+ + p$. Wakano, M. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 2, 704-706 (Aug 1973).

Contributions to the A_1 exchange, as well as the pion exchange, to the differential cross section for the $\pi^+p \rightarrow \rho^+p$ interaction are calculated by applying the Gottfried-Jackson absorption model with the Born helicity amplitudes. (LBS)

1466 SIMULATIONS OF INCLUSIVE π^+p REACTIONS AT 16 GeV/c. Beaupre, J. V. (Technische Hochschule, Aachen). Nucl. Phys.; B71: No. 3, 421-428(1974).

The influence of inclusive phase space on semi-realistic multiplicity and matrix element assumptions is studied for π^+p inclusive reactions at 16 GeV/c. It is concluded that a large part of the beam-like leading pion effect is due to charge conservation. The simulated $\langle p_\perp \rangle$ is about 60% of that expected from the matrix elements alone. (auth)

1467 PADE APPROXIMANT MODEL OF THE NUCLEON PROPAGATOR. Barlow, R. H. (Vrije Univ., Brussels). Nucl. Phys.; B71: No. 3, 439-444(1974).

The (1/1) Padé approximant to the perturbation series of the interacting nucleon propagator generated by considering the standard Yukawa theory of pion-nucleon interactions and extended to include the interactions of σ and η mesons with nucleons is considered. One might hope that this approximation would contain the P_{11} (1470 MeV) and S_{11} (1520 MeV) resonances of pion-nucleon elastic scattering. This was not the case and in fact the Padé approximant result violated the Lehmann positivity conditions in the region of these resonances. (auth)

1468 STUDY OF ROLE OF INTERFERENCE TERM IN THE TWO-PARTICLE NUCLEAR REACTION $K^-p \rightarrow \Lambda\pi^0$ ON THE BASIS OF THE POLE-RESONANCE MODEL. Watal, C. (Univ. of Allahabad, India). Indian J. Pure Appl. Phys.; 11: No. 7, 449-451(Jul 1973).

An analysis of the differential cross section and the polarization data of Armenteros et al., [Nucl. Phys., B21 (1970), 15] for the reaction $K^-p \rightarrow \Lambda\pi^0$ in the K^- momentum range of 440 to 800 MeV/c is reported. A reasonable agreement with the experimental data is obtained by combining the K^*-exchange amplitude with the contribution of several known I = 1 resonances in the direct channel. (auth)

1469 PARAMETRIZATION OF REGGE Δ EXCHANGE FOR BACKWARD πN QUASI-TWO-BODY SCATTERING. Schneider, F.; Schlitt, D. W. (Univ. of Nebraska, Lincoln). Acta Phys. Pol.; B5: No. 2, 155-166(1974).

A parametrization of Regge residue for Δ exchange which incorporates MacDowell symmetry, sense-nonsense zeros, constraints and cancellation of kinematic singularities is proposed. Absence of the parity partner of the (3,3) resonance is included through a zero in the residue. Explicit results are given for the cases of $\pi^-p \rightarrow \pi^-p$, ρ^-p, A_1^-p, and A_2^-p using the Gell-Mann choosing nonsense mechanism. Other sense-nonsense behaviours are discussed. (auth)

Strong (Baryon No. ≥ 2)

1470 (HU-TFT-73-28) EFFECT OF THE $\Delta(1236)$ IN THE TWO NUCLEON PROBLEM AND IN NEUTRON MATTER. Green, A. M., Haapakoski, P. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1973. 52p. Dep. NTIS (U. S. Sales Only) $5.75.

A two nucleon interaction for the $^1S_0$ state is constructed by replacing the σ-meson in a OBEP by an inelastic process involving the $\Delta(1236)$. The values of the two free parameters introduced to fit $\delta(^1S_0)$ are justified by more fundamental approaches. The binding energy of neutron matter is calculated, and it is shown there is a considerable repulsive contribution not present for an equivalent σ-meson interaction. (auth)

1471 (INP-856) EXPERIMENTAL TESTS OF GOTTFRIED'S MODEL FOR MULTIPLE PRODUCTION OF PARTICLES IN HADRON-NUCLEUS COLLISION. Holynski, R.; Krzwozinski, S.; Zalewski, K. (Institute of Nuclear Physics, Krakow (Poland)). Nov 1973. 13p. Dep. NTIS (U. S. Sales Only) $4.00.

Gottfried's theory of multiple production of particles in hadron-nucleus collisions is compared and found consistent with experimental data. The theory and the data are used to predict the inclusive distribution in $-\ln \tan \Theta_L/2$ for particles produced in proton-arbitrary nuclear target collisions at 67 and 200 GeV/c incident momentum. (auth)

1472 (INR-1448) STRUCTURES IN PROTON-PROTON ELASTIC CROSS SECTION AND TWO COMPONENTS OF POMERON. Swiecki, M.; Wilk, G. (Institute of Nuclear Research, Warsaw (Poland)). 1973. 12p. Dep. NTIS (U. S. Sales Only) $4.00.

A two-component model for pomeron is used in order to explain structures in elastic proton-proton cross section obeserved at ISR energies. (auth)

1473 (ITF-73-163-E) EFFECT OF P-WAVE π-N INTERACTION OF THE PION-DEUTERON SCATTERING LENGTH. Peresypkin, V. V.; Petrev, N. M. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1973. 10p. Dep. NTIS (U. S. Sales Only) $4.00.

The problem of the elastic scattering of zero-energy π-mesons by deuteron is considered on the basis of Faddeev equations. The assumption is made that the π-N interaction takes place in the S- and P-state and is described by a potential with separable variables. The dependence of π-N scattering length on the form of two-body interaction and on the value for scattering lengths is studied. (auth)

1474 (JINR-E4-7721) METHOD FOR THE CALCULATION OF REAL WEINBERG FUNCTIONS USING THE SAXON-WOODS POTENTIAL. Schulz, H.; Efimov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 16p. Dep. NTIS (U. S. Sales Only) $4.00.

A method is proposed for the calculation of real Weinberg functions at positive energies using the Saxon-Woods potential. The on-shell K-matrix for s-waves is calculated and compared with the exact one. As an application of the method proposed the neutron strength function is calculated considering a complex potential. (auth)

1475 DISTRIBUTIONS IN A TWO-COMPONENT MODEL WITH LEADING NUCLEONS. de Groot, E. H. (Oxford Univ.); Kajantie, K.; Ruuskanen, P. V. Nucl. Phys.; B71: No. 2, 241-268(1974).

Proton and pion distributions and multiplicities are analyzed in a two-component model in which the diffractive component is given on the basis of the pionization component by assuming that a pomeron-particle collision behaves as a particle-particle collision. For the pionization component a simple but general ansatz with leading nucleons is used. Particular attention is given to analyzing the dependence of the diffractive pion spectrum and multiplicity on the behavior of the throughgoing proton. Nucleon-nucleon, pion-pion and pion-nucleon correlations are considered. Single particle distributions are compared with experimental data from CERN ISR. (auth)

1476 SOME CONSEQUENCES OF THE KNO SCALING LAW FOR CHARGE MULTIPLICITY DISTRIBUTIONS. Counihan, M. J. (CERN, Geneva). Lett. Nuovo Cim.; 9: No. 14, 561-564(6 Apr 1974).

An analysis is made of $\langle n \rangle/D$ ratios for multiplicity distributions in pp scattering between 19 and 303 GeV/c, which indicates that present data are consistent with the KNO prediction that this ratio should be a constant if $\langle n \rangle$ and D are interpreted in terms of a continuous rather than a discrete distribution. Simple rules were obtained for the modal value of the multiplicity distribution and for the peak fraction of the inelastic cross section for n-prong events. The agreement with available data on pp collisions provides further support to the validity of the KNO scaling law at presently accessible energies. (auth)

1477 SCALING LAW FOR THE ELASTIC DIFFERENTIAL CROSS SECTION IN pp SCATTERING FROM GEOMETRIC SCALING. Buras, A. J.; Dias de Deus, J. (Univ. of Copenhagen). Nucl. Phys.; B71: No. 3, 481-492(1974).

Plots of $(1/\sigma_{in}^2)d\sigma_{el}/d|t| \equiv \Phi(\tau,s)$ as a function of $\tau \equiv |t|\sigma_{in}$ are shown to scale in the NAL-ISR energy region. Such scaling is shown to be a consequence of geometric scaling for the inelastic overlap function $G_{in}(\beta \equiv \pi b^2/\sigma_{in})$ in the limit $\rho \equiv \mathrm{Re}A/\mathrm{Im}A \rightarrow 0$ and

in the case of $\sigma_{in} \sim (|ns)^2$ is equivalent to the scaling proposed by Auberson, Kinoshita and Martin. A possible relation to the KNO multiplicity scaling is indicated. (auth)

1478 CHARGE DISTRIBUTION OF PARTON AND SCALING IN $p + p \rightarrow l^+ + l^- +$ ANYTHING. Roychowdhury, R. K.; Roychowdhury, A.; Roy, T. (Jadavpur Univ., Calcutta). Progr. Theor. Phys. (Kyoto); 50: No. 1, 337-338(Jul 1973).

The formation of charge distribution of partons is applied to lepton-pair production in pp interactions. Scaled functions are obtained which are in agreement with dual resonance model predictions. A plot of $d\sigma/dq^2$, where q^2 is the invariant mass of the lepton pair, against q^2 is found to be in agreement with experimental data. (LBS)

1479 POSSIBLE EXPLANATION OF INCLUSIVE SPECTRA AT LARGE TRANSVERSE MOMENTUM. Sakai, S. (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 50: No. 5, 1644-1652(Nov 1973).

A model for inclusive reaction at large k_T and at ISR energy is proposed. The model assumes massive particles which decay into several pions. The model naturally explains qualitative features of particle production ratios (K/π, $\bar{p}/\pi^-$ and n^+/n^-) at large k_T as well as increase of inclusive cross section with incident energy at large k_T. Further the difference of inclusive cross section at large k_T between accelerator and ISR-energies are also explained. Then in order to make k_T-distribution smooth, mass levels of these massive particles are estimated and fits to the data are made. The results say that the mass intervals of these massive particles are broader than 1.5 GeV. Therefore if there are more dense mass levels as Regge pole models predict, the k_T-distribution surely becomes smooth. (auth)

1480 CORRELATIONS BETWEEN THE LEADING PROTON AND PIONS IN HIGH ENERGY PROTON-PROTON COLLISIONS. Kasman, J. (Univ. of London). Nuovo Cim.; 20A: No. 4, 647-654(21 Apr 1974).

The study of inclusive rapidity spectra $pp \rightarrow pX$ and $pp \rightarrow p\pi X$ at high energies provides a test of the assumptions of the diffractive excitation model. The magnitude and shape of correlations between the leading proton and produced pions favours a modified model, in which the diffractive cluster decays longitudinally, rather than isotropically. (auth)

1481 INDEPENDENT PRODUCTION OF PARTICLE CLUSTERS: A THIRD GENERAL FEATURE OF HIGH ENERGY HADRON COLLISIONS. Pokorski, S.; Van Hove, L. (CERN, Geneva). Acta Phys. Pol.; B5: No. 2, 229-245(1974).

The experimental facts on two-particle correlations and charge transfer in high energy proton-proton collisions suggest that the secondaries in the central rapidity region are produced in clusters of dominantly neutral charge and low multiplicity, these central clusters being independently emitted. Since fragmentation of either incident hadron is in effect formation of a leading cluster, one is led to a unified picture of independent cluster production (ICP) for all common inelastic collisions. The evidence for ICP is first reviewed and an estimate is given of the mass and multiplicity distributions for central clusters. Following Stodolsky, it then uses the bremsstrahlung analogy to express the leading particle spectrum $d\sigma/dx$ in terms of the density ρ of central clusters. On the basis of ISR data, agreement between the approximate constancy of $d\sigma/dx$ for $0.2 \lesssim x \lesssim 0.8$ and our estimate of $\rho \simeq 0.9-1.2$ is found. The p_T properties of clusters are also discussed by using the condition that the overlap function should agree with elastic data. A possible interpretation of ICP in terms of the present view on hadron structure based on deep inelastic lepton-nucleon scattering experiments, which suggests that a hadron is mainly composed of its "valence quarks" and of neutral "glue" (there is in addition a probably infinite number of quark-antiquark pairs, but the total amount of four-momentum they carry is very small). High energy hadron collisions can then be pictured as follows. The valence quarks fly through and give rise to the leading particles or clusters, while some glue can be radiated away in bremsstrahlung-like fashion and gives rise to the central clusters. (auth)

1482 THREE-CHANNEL TREATMENT OF $^1D_2$ p-p ELASTIC AND INELASTIC REACTIONS IN THE 600 MeV REGION. Suzuki, H. (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 50: No. 3, 1080-1082(Sep 1973).

The pp reactions in the $^1D_2$ state are investigated in the elastic and inelastic regions by the three-channel N/D formalism in an attempt to obtain the phase shift in the inelastic region. The inelastic events in the sub-GeV region are dominated by one π production through $N\text{-}N^*_{33}$ and π^+-D channels. A good fit was obtained to the elastic data; on the other hand, the fit to the inelastic data, especially for the $p + p \rightarrow \pi^+ + D$, was not sufficient. (LBS)

1483 DEUTERON DISINTEGRATION BY HIGH-ENERGY ELECTRONS. Chelkowski, S. (Jagellonian Univ., Krakow); Chylinski, Z.; Pszon, J. Acta Phys. Pol.; B5: No. 2, 183-194 (1974).

The semi-relativistic approach, widely applied to the two-body problem, is generalized onto the three-body disintegration process of deuteron by a high energy electron. The proposed way of description of fast moving, Lorentz contracted, composite systems leads to small anisotropy of the angular distribution of the "spectator" nucleon in the lab-system. This effect increases with energy, but it saturates for electron energy of the order of 20 GeV. (auth)

1484 EFFECTIVE POTENTIAL AND OFF-SHELL TWO-BODY SCATTERING AMPLITUDES IN THE EIKONAL APPROXIMATION. Bartnik, E. A. (Univ., Warsaw); Rek, Z. Acta Phys. Pol.; B5: No. 2, 195-207(1974).

An effective potential is computed for 2-body elastic scattering with the experimental on-shell t-matrices as an input. Nonrelativistic eikonal approximation and locality, together with spherical symmetry of potential, are assumed. The explicit form of potential for pp, π^+p and π^-p in the energy range from 5 to 20 GeV is investigated. The half off-shell scattering amplitude is calculated in the potential model. In the position representation this amplitude is found to be asymmetric along the eikonal direction, and an interesting absorption interpretation of this fact is given. (auth)

1485 ANISOTROPY OF ANGULAR DISTRIBUTIONS OF SPECTATOR NUCLEONS FROM DEUTERON DISINTEGRATION. Chylinski, Z.; Pszon, J. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., B5: No. 2, 309-314(1974).

It is shown that the relativistic contraction of the wave function of deuteron results in a small positive forward-backward asymmetry of the spectator nucleon from the disintegration of deuteron. This effect is compared with the Dubna experiment of $dp \rightarrow ppn$ process at 3.3 GeV/c deuteron momenta. (auth)

1486 SEPARABLE REPRESENTATION OF THE NUCLEON-NUCLEON INTERACTION IN THE $^3S_1-^3D_1$ CHANNEL. Afnan, I. R.; Read, J. M. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys.; 26: No. 6, 725-738(Dec 1973).

A separable representation for the two-nucleon T-matrix in coupled channels was obtained from a unitary pole expansion for the potential, and the method was tested with the Reid soft-core potential in the $^3S_1-^3D_1$ channel. A 3-term expansion provides a T-matrix that is sufficiently accurate for a perturbation theory calculation of the three-nucleon bound state, while a 15-term expansion closely reproduces the exact T-matrix. In addition, a unitary pole approximation is presented that gives a better fit to the phase shifts and coupling parameter than that of Siebert et al. (1972). (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 1794.

1487 REMARKS ON DYNAMICAL NONCOMPACT GROUPS IN PHYSICS AND CHEMISTRY. Sinanoglu, O. (Yale Univ., New Haven). Int. J. Quant. Chem., Symp.; No. 7, 45-52(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

In contrast to the usual degeneracy or symmetry groups, the new dynamical groups generate all the energy levels and spectrum of a system in one infinite-dimensional representation. The origin and nature of these groups as they came up first in high energy physics, then in atomic physics, are outlined. The known dynamical groups, e.g., for the rigid rotor, the harmonic oscillator, and the hydrogen atom, are displayed. Possible applications in molecular spectroscopy are discussed. (auth)

1488 SPONTANEOUS DYNAMICAL BREAKING OF GAUGE SYMMETRY IN DUAL MODELS. Cremmer, E. (Paris Univ., Orsay, France). Nucl. Phys.; B72: No. 1, 117-124(1974).

The consequences of gauge invariance are re-examined in dual models with unit intercept when the dimension of space-time has the maximum value compatible with the absence of ghosts. In that case, reggeon-reggeon bound states of zero mass are formed already at second order of perturbation theory. Gauge invariance no longer guarantees that the initially massless SU(3) singlet vector meson remains massless, and the mixing between the reggeon

and pomeron sectors of the model yields a massive unitary singlet vector meson already at order g^2. A Lagrangian model which exhibits similar features to the dual situation is discussed. (auth)

1489 FINITE- AND INFINITE-DIMENSIONAL REPRESENTATIONS OF THE LORENTZ GROUP. Carmeli, M. (Univ. of Negev, Beer Sheva, Israel); Malin, S. Fortschr. Phys.; 21: No. 8, 397-425(1973).

Finite- and infinite-dimensional representations of the Lorentz group are discussed, and various topics in which this group is currently in use are mentioned. The infinitesimal approach of finding representations is reviewed and all finite-dimensional spinor representations of the Lorentz group are obtained. Infinite-dimensional representations are then discussed, including the principal, complementary, and complete series of representations. A generalized Fourier transformation is introduced which enables one to use the global approach to representation theory so as to express infinite-dimensional representations in terms of matrices. This method is shown to lead to a generalization of the spinor form of finite-dimensional representation to the infinite-dimensional case. However, whereas the usual spinor representations are non-unitary, the obtained new form describes both unitary and non-unitary representations, depending on the choice of certain parameters appearing in the representation formula. (auth)

1490 TENSOR REPRESENTATIONS OF CONFORMAL ALGEBRA AND CONFORMALLY COVARIANT OPERATOR PRODUCT EXPANSION. Ferrara, S.; Grillo, A.F. (Laboratori Nazionali di Frascati del CNEN, Frascati, Italy); Gatto, R. Ann. Phys. (N.Y.) 76: No. 1, 161-188 (Mar 1973).

A conformally covariant formulation of operator product expansion is discussed as an expansion of the product of two representations into a direct sum of irreducible representations. The basic irreducible representations are analyzed and classified. The isomorphism between the conformal algebra and the O(4,2) algebra is used to obtain a manifestly covariant formalism. The implications of the isomorphism in the derivation of the representations is discussed. The covariant O(4,2) formalism directly relates dominant terms to nondominant terms in the light-cone limit. The essential coincidence of the problem of a conformal covariant operator product expansion to the problem of determining the form of the three-point function is stressed, together with the relevance of a selection rule for two-point functions following from exact (not spontaneously broken) conformal covariance. The role of Ward identities in a conformal convariant scheme is pointed out, and the mathematical implications on the n-point functions from causality are described. (auth)

Applications (Electromagnetic and Weak)

1491 (COO-2232-B-44) CALCULABILITY AND NATURALNESS IN GAUGE THEORIES. Georgi, H.; Pais, A. (Harvard Univ., Cambridge, Mass. (USA). Lyman Lab. of Physics; Rockefeller Univ., New York (USA)). 1973. Contract AT(11-1)-2232. 58p. Dep. NTIS $6.00.

Calculability conditions are discussed for local gauge theories with Higgs type symmetry breaking. The naturalness of μe-universality; the naturalness of the Cabibbo angle θ; the naturalness of CP-violating phases; and the naturalness of nonleptonic $\Delta I = \frac{1}{2}$ are emphasized. In this context many published gauge models are examined, and others are constructed to illuminate the questions at hand. It is noted that naturalness of μe-universality for charged currents does not necessarily imply universality for neutral currents, (natural "restricted" universality), and the need for ν_e-beam experiments is emphasized. For SU(2) × U(1) and SU(2) × U(1) × U(1) first examples are given of how a nontrivial natural θ can appear. Models with CP-violation are classified as to whether their CP-violating phases are natural or not. For O(4) × U(1) a first example is given in which all the above naturalness criteria can be implemented. The natural μe-universality is necessarily restricted. The principal tool used in these investigations is the strict renormalizability relative to a gauge group enlarged by discrete symmetries; and the union of representations reducible under the gauge group to irreducible ones under the enlarged group. To implement this program, it is sometimes necessary to introduce Higgs couplings involving right-handed neutrinos; the zero neutrino mass is associated with a discrete symmetry which remains unbroken upon spontaneous breakdown. It is also found that strict renormalizability can lead to mass relations between fermions. In O(4) × U(1) models, such mass relations as well as right-handed neutrinos are necessary ingredients. Furthermore, for these models the spontaneity of CP-violation acquires an operational significance, namely as a discrete symmetry necessary (but not sufficient) to give a CP-violating phase a natural value (90°). While the models discussed are rather cumbersome, particularly due to the complexity of the symmetry breaking mechanism, it is expected that the tools developed may well have wider applicability. (auth)

1492 TESTS FOR PARITY CONSERVATION IN THE ELECTROMAGNETIC INTERACTION OF HADRONS. Wolfenstein, L. (CERN, Geneva). Nucl. Phys.; B72: No. 1, 111-116(1974).

Experimental limits on the possible coupling strength (ef) of a conserved hadronic axial current coupled to the photon are examined. The strongest limit, $f \leq 10^{-4}$, is deduced from the virtual photon contribution to the parity forbidden alpha decay of the 2^- excited state of ^{16}O. The limit based on processes involving real photons is two orders of magnitude larger. Further experiments are suggested. (auth)

Applications (Strong)

Refer also to abstract 1463.

1493 PP- AND PB-SCATTERING LENGTHS AND BROKEN NON-LINEAR CHIRAL SU(3) × SU(3)-DYNAMICS. Torich, Z. Z. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 134-140(Jan 1974). (In Russian).

The meson-baryon Lagrangian invariant relative to nonlinear chiral transformations of the SU(3) × SU(3) group is broken in two ways: the multiplet breaking and the $(3.3^*) + (3^*.3)$ breaking are considered. s- and p-wavelengths of PP- and PB-scatterings are calculated on the basis of the broken Lagrangians. The comparison with available experimental data and other theoretic predictions is carried out. (auth)

1494 REGGE COUPLINGS FROM SU(2) × SU(2) SATURATION SCHEMES. Kleinert, H. (Freie Univ., Berlin). Fortschr. Phys.; 21: No. 8, 377-396(1973).

For any saturation scheme of the chiral SU(2) × SU(2) charge algebra a simple algebraic method of calculating the couplings of ρ and f trajectories to all particles involved is developed. The information on these coupling is shown to be directly contained in the chiral mass splittings among the different isospin multiplets. (auth)

1495 ON CHIRAL SYMMETRY BREAKING. II. Darzens, C. (Centre de Physique Théorique de l'Ecole Polytechnique, 17, rue Descartes, 75 Paris V, France). Ann. Phys. (N.Y.) 76: No. 1, 236-250 (Mar 1973).

We study the restrictions imposed on chiral symmetry breaking terms by a set of postulates, whose main content is furnished by certain ideas of Michel and Radicati. We then test certain particular cases by utilizing an effective Lagrangian and calculating meson–meson scattering lengths. A convenient technique for calculating traces of matrices which appear in our model is presented in an appendix. (auth)

1496 CHIRAL PERTURBATION THEORY. Langacker, P.; Pagels, H. (Rockefeller Univ., New York). Phys. Rev., D; 8: No. 12, 4595-4619(15 Dec 1973).

Perturbation theory is considered for SU(2) × SU(2) and SU(3) × SU(3) chiral symmetries realized by Nambu–Goldstone bosons. Exact expressions are derived for the derivatives with respect to the symmetry-breaking parameter ϵ of Green's functions, scattering amplitudes, and the matrix elements of operators, including the effects of renormalization and the external mass-shell constraints. These expressions are used to systematically classify all leading nonanalytic behavior in the expansion of these quantities around $\epsilon = 0$. It is found that S-matrix elements go to finite limits as $\epsilon \to 0$. They in general approach this limit in a nonanalytic $\epsilon \ln\epsilon$ manner. At exceptional momentum points, corresponding to the low-energy theorems of current algebra, the leading nonanalytic corrections can be absorbed into the renormalization of the parameters (such as f_π) of the theory by the symmetry-breaking interaction. Hence leading-order corrections to low-energy theorems are expected to be analytic. The errors in off-shell partial-conservation-of-axial-vector-current extrapolations are often of order $\epsilon \ln\epsilon$ and can be calculated exactly. The matrix elements of two or more zero-energy operators can diverge as $\ln\epsilon$ or $1/\epsilon$ or worse in the chiral limit. The leading corrections in SU(2) × SU(2) expansions are very small (a few percent). Expansions around SU(3) × SU(3) are marginal. The corrections are often 30% and in one case are larger than the leading term. The leading renormalization of the meson decay constants is calculated, and the $\pi\pi$ and πN amplitudes are considered in some detail. (auth)

Scattering Theory

Refer also to abstracts 1337, 1717, and 1805.

1497 (IFVE-STF-73-31) CONCERNING ONE EQUATION FOR PHYSICAL SCATTERING AMPLITUDE. Savrin, V. I.; Tyurin, N. E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh

Ehnergij). 1973. 25p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.25.

The single-time formulation of two-body problem in quantum field theory is considered, and the equation for physical scattering amplitude, which generalizes the known Heitler–Sokolov equation for relativistic case, is obtained. The analytical properties of scattering amplitude are investigated in the framework of this equation. The problem on Regge trajectory behavior at high energies is discussed. (auth)

1498 NUMERICAL STRATEGIES IN THE CONSTRUCTION OF AMPLITUDES SATISFYING UNITARITY, ANALYTICITY AND CROSSING SYMMETRY. I. Boguta, J. (Univ. of Illinois, Chicago). Nucl. Phys.; B72: No. 1, 167-188(1974).

Numerical strategies for the construction of amplitudes satisfying Mandelstam unsubtracted analyticity, crossing, elastic unitarity exactly and preserving inelastic unitarity bounds are studied. A slightly modified set of equations are considered. The various strategies are compared and the number of iterations required to yield a converging solution established. Further numerical simplifications are proposed. (auth)

1499 OPERATOR PRODUCT EXPANSIONS AT LARGE DISTANCES AND REGGE ASYMPTOTIC BEHAVIOR. Brandt, R. A. (New York Univ., NY). Nucl. Phys.; B72: No. 1, 125-148(1974).

The class of theories is considered in which the simplest high-energy scattering processes are described by the exchange of a Regge pole or cut and in which light-cone behavior is described by operator product expansions. The scattering processes are those in which an initial particle interacts with an initial cluster of other particles to produce a final particle and final cluster. The high energy limit is that in which the energy of the initial particle relative to the energy of any particle in the clusters becomes large with fixed masses, momentum transfers and cluster sub energies. It is shown that these limits can be completely characterized by an operator statement on the product of the interpolating fields of the initial and final particles, independently of the initial and final clusters. Given then that these limits correspond to large distance limits in space-time, operator product expansions are obtained which describe in an operator manner the behavior of a product $A(x)B(0)$ of local fields in the large distance limit $x_0 \to \infty$ with x^2 fixed. This provides an exact operator picture of a Regge pole being built out of an infinite set of elementary spin exchanges. The crucial ingredient in the derivation is the factorization property of Regge poles or Regge cut discontinuities. The leading light-cone contribution to the scattering amplitude will then have the same factorization properties. The operator expansion is derived first for single particle matrix elements, first using commutativity of the Regge and scaling limits and second using diagonalized Bethe–Salpeter equations for the matrix elements of the local fields in the light-cone expansion. It is then deduced for single-double particle matrix elements using the second method where now helicity sums play an important role. It is finally derived for arbitrary matrix elements. Non-leading Regge poles and Regge cuts can be similarly described by using also non-leading light-cone singularities. (auth)

1500 S-MATRIX ELEMENTS IN THE PRESENCE OF SHADOW STATES. The Bjorken Limit and Shadow Quarks. Nelson, C. A. (Louisiana State Univ., Baton Rouge). Nucl. Phys.; B72: No. 1, 10-40(1974).

When a scattering reaction occurs, it is usually assumed that the complete set of collision states is entirely composed of traveling waves, hence any constituent, in principle, is observable. Should, however, either quarks, regulator photons or lepton satellites be standing wave states, i.e., only shadow states, we would not expect to have observed them. The new terms which modify the usual dispersion relations and the Low equation are discussed and it is argued that present two-body experiments do not provide strong tests for their presence. In the Bjorken limit these piecewise analytic terms vanish. Yet, in a shadow indefinite-metric theory, the logarithmic terms breaking this limit are still absent. The triangle anomalies, therefore, should only be taken seriously in low energy reactions. A stronger constraint on the presence of shadow states can be provided by verification of the Callen–Gross sum rule. By means of a simple version of the Kuti–Weisskopf model, containing valence quarks and quark-antiquark pairs, it is demonstrated explicitly how quarks can be shadow states. In an appendix, in formal scattering theory with shadow states, the correct formal solutions for the exact asymptotic states, both physical and shadow, are obtained. (auth)

1501 FIRST AND SECOND BOUND STATE FOR A THREE-BODY SYSTEM ASSUMING A LOCAL TWO-BODY POTENTIAL WITH REPULSIVE TERM. Giardini, I. M.; Zanon, D. (Univ., Milan). Lett. Nuovo Cim.; 9: No. 14, 575-579(6 Apr 1974).

The Faddeev equations are studied for a system of three identical and spinless particles. A local two-body potential is assumed that contains a short-range repulsive term. Use is made of the variational technique, that exploits some precise connections with the Pade approximants, in order to obtain the binding energies of the first and second bound state of the system. (LBS)

1502 CDD POLES, INELASTICITIES, AND OPTIMIZATION OF N/D EQUATIONS. Ciulli, S.; Pomponiu, C.; Sabba-Stefanescu, I.; Steinbrecher, G. (Joint Inst. of Nuclear Research, Dubna, USSR). Nucl. Phys.; B71: No. 2, 269-291(1974).

In solving a mathematical problem where the input consists of data endowed with some precise property—as that of being limiting boundary values of holomorphic (and unitary) amplitudes—one can proceed in many (usually infinitely many) equivalent ways. It is important to notice that this equivalence is broken when noise appears under some form, either because of the lack of precision of the data one is provided with, or because of mere lack of knowledge concerning them on some regions. One is then faced with the meaningful question of finding among all tautological ways of solving the problem, that one which leads to results closest to the ideal (precise) ones. The optimization in the above sense of the N/D equations (started in a previous work) is considered. Its first part is concerned with the determination of allowed regions for the residua of the CDD poles, from conditions of consistency with a specified allowed error-channel. Its second part treats the question of optimization in the presence of inelasticities—first globally, with the Chew–Mandelstam and Froissart parameterizations—and finally generalizes the procedure to binary coupled channels (matrix N/D equations). Apart from the mathematical aspect, an attempt is made to provide workable formulas ready for applications. (auth)

1503 FACTORIZATION OF DISCONTINUITIES OF MULTI-REGGE AMPLITUDES. Weis, J. H. (CERN, Geneva). Nucl. Phys.; B71: No. 2, 342-364(1974).

It is shown that an arbitrary discontinuity of an arbitrary multi-Regge amplitude factorizes in a large class of models which encompasses the dual resonance model. It is argued that multiple discontinuities also factorize and that the factorization of discontinuities is expected to hold on very general grounds as a result of the singularity structure of multiparticle amplitudes. These results allow the full amplitude as well as its discontinuities to be written as a product of Regge propagators, single-, double-, and triple-Regge vertices and their discontinuities. (auth)

1504 LOW-ENERGY SCATTERING BY LONG-RANGE POTENTIAL. Fabrikant, I. I. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 6, 11-18 (1973). (In Russian).

Particle scattering by a long-range potential is considered using the iterative solution method of the integral equation for the wave function. (auth)

1505 DUAL AMPLITUDES WITH MANDELSTAM ANALYTICITY. Bugrii, A. I.; Cohen-Tannoudyi, G.; Enkovskii, L. L.; Kobylinskii, N. A. (Inst. for Theoretical Physics, Kiev). Fortschr. Phys.; 21: No. 9, 427-506(1973).

A class of dual amplitudes with Mandelstam analyticity (DAMA) is studied. A detailed analysis of the analytic and asymptotic properties of the amplitudes in the complex s and t plane is carried out. The role of the amplitudes for the construction of an analytic S-matrix theory is discussed. Applications to physical processes are also presented. (auth)

1506 SCATTERING IN CELL MODEL FIELD THEORIES. Grimmer, H. (Battelle Advanced Studies Center, Geneva). Nuovo Cim., 20A: No. 4, 570-584(21 Apr 1974).

A class of Hamiltonian model field theories having genuine interaction effects, and which are nonrenormalizable in the traditional sense, have been shown to describe scattering. Although the models do not have particle production in the true sense, an interchange can occur among two species of particles. The limit of the Hamiltonian as the interaction is turned off differs fundamentally from the free Hamiltonian, constructed from the classical Hamiltonian by the correspondence principle. (auth)

1507 SINGULARITIES OF THE S-MATRIX AND GREEN'S FUNCTION ASSOCIATED WITH PERTURBATIONS OF $-\Delta$ ACTING IN A CYLINDER. Goldstein, C. I. (Univ. of Wisconsin, Madison). Bull. Amer. Math. Soc.; 79: No. 6, 1303-1307(Nov 1973).

The singularities of the S matrix and Green function with the operators considered previously are studied. It is found that there are a countable number of branch points as well as a countable number of different S matrices associated with these operators. (JFP)

1508 SINGULARITIES OF THE TRIANGLE DIAGRAM VERTEX FUNCTION. Frederiksen, J. S. (Univ., Groningen, Netherlands); Woolcock, W. S. Aust. J. Phys.; 26: No. 6, 691-701(Dec 1973).

The definition of a singularity of an integral of Cauchy type is made precise under certain conditions. These conditions are shown to hold for the triangle diagram vertex function, and the positions of its singularities are studied. (auth)

1509 QUANTUM MOMENTUM METHOD FOR THE EXACT SOLUTION OF SEPARABLE MULTIPLE WELL BOUND STATE AND SCATTERING PROBLEMS. Lee, S. Y.; Light, J. C. (Univ. of Chicago). Chem. Phys. Lett.; 25: No. 3, 435-438(1 Apr 1974).

A simple method is suggested for the convenient application of Milne's method of solution of the one-dimensional Schrödinger equation to multiple well potentials. The method involves the introduction of "quantum momentum" functions which resemble the classical momentum over each "well". The wave function is matched at intermediate points between the "wells", and the quantization requirements are determined. The double oscillator and scattering by spherically symmetric potentials are cited as applications. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

1510 (COO-3077-35) HELIUM AT ZERO TEMPERATURE WITH HARD-SPHERE AND OTHER FORCES. Kalos, M. H.; Levesque, D.; Verlet, L. (New York Univ., N. Y. (USA). AEC Computing and Applied Mathematics Center). Sep 1973. Contract AT(11-1)-3077. 71p. Dep. NTIS $6.75.

Various theoretical and numerical problems relating to helium-like systems in their ground states are treated. New developments in the numerical solution of the Schrodinger equation permit the solution of 256 body systems with hard-sphere forces. Using periodic boundary conditions, fluid and crystal states can be described; results for the energy and radial distribution functions are given. A new method of correcting for low lying phonon excitations so as to extrapolate the energy of fluids to an infinite system is described. A perturbation theory relating the properties of the system with pure hard sphere forces to those with smoother, more realistic two body forces is introduced. As in recent work on classical systems the potential is divided into two continuous parts; one is repulsive, one attractive, the latter being treated as a perturbation. The solution for the repulsive part is taken directly from the hard sphere problem when the radius is identified as the scattering length of the repulsive part of the smooth potential. The convergence for the Lennard–Jones potential is very good. Using our numerical results for the hard sphere problem, with phonon corrections, together with this perturbation theory, results for energy vs. density agree with experiment within our error of 3 to 10% except at high crystal densities. Schiff's recent application of this perturbation theory are carried further to He^3 and it is concluded that antisymmetrization by the method of Wu and Feenberg is the reason for lack of agreement with experiment in that system. (auth)

1511 (HU-TFT-73-29) CONDENSATE SPIN CURRENTS IN HELIUM-3. Vuorio, M. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Nov 1973. 9p. Dep. NTIS (U. S. Sales Only) $4.00.

Condensate spin currents are discussed in the Ginsburg–Landau framework for the Anderson–Brinkman and the Balian–Werthamer p-wave states of helium-3. The dipolar energy is calculated and its effect on the stability of the spin current states is considered. Minimizing the free energy expression is employed to get values for the critical velocities. (auth)

1512 UPPER LIMIT TO ROTATIONAL COOLING IN SUPERFLUID HELIUM. Deconde, K.; Packard, R. E. (Univ. of California, Berkeley). Phys. Lett.; 47A: No. 3, 233-234(25 Mar 1974).

The results are presented of a calculation and experiment which show that rotation of He II in packed powder will not produce a decrease in temperature greater than 2×10^{-5}K. This is in contrast to a recent prediction. (auth)

1513 GINZBURG–LANDAU EXPANSION OF THE FREE ENERGY OF A SPATIALLY INHOMOGENEOUS ANISOTROPIC BCS-SUPERFLUID. Woelfle, P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Phys. Lett.; 47A: No. 3, 224-226(25 Mar 1974).

It is argued that the coefficients of the second order gradient terms in the free-energy expansion of an anisotropic BCS-superfluid may be calculated in "weak coupling theory". For the Anderson–Brinkman state the supercurrents and the dispersion law of orbital waves are calculated. (auth)

1514 CRITICAL PHENOMENA 1965–1972: QUESTIONS AND ANSWERS. Green, M. S. (National Bureau of Standards, Washington, DC). Rev. Mex. Fis.; 21: No. 4, 279-290(1972).

Recent advances on the field of critical phenomena are discussed. The discussion is restricted to three main problems: a) What is the nature of the singularities in the thermodynamic properties near the critical point? b) How do the exponents which express these singularities depend on the physical nature of the system? and c) Which transport properties are anomalous near the critical point?. (auth)

1515 POWER SERIES EXPANSION OF PHONON SPECTRUM IN LIQUID HELIUM. Lin-Liu, Y. R.; Woo, C. W. (Northwestern Univ., Evanston, IL). J. Low Temp. Phys.; 14: No. 3-4, 317-329 (Feb 1974).

With the aid of accurate microscopic calculations and rigorous sum rule arguments, available data on the phonon spectrum in liquid helium are analyzed. In particular a Tamm–Dancoff calculation of the correction to Feynman's spectrum is presented and it is shown that low-order perturbation calculations are valid. Without making any undue statement about the dispersion formula in the hydrodynamic region, it is concluded that at least for $0.3 < q < 0.7$ Å^{-1} experimental data from inelastic neutron scattering and elastic x-ray scattering are on the whole consistent. (auth)

1516 EXPERIMENTS WITH ^{3}He QUASIPARTICLES IN THE COLLISIONLESS REGIME. I. A Direct Measurement of the Fermi Velocity by Heat Conduction. Betts, D. S.; Brewer, D. F.; Hamilton, R. S. (Univ. of Sussex, Brighton, Eng.). J. Low Temp. Phys.; 14: No. 3-4, 331-347(Feb 1974).

Measurements of the thermal conduction of liquid ^{3}He in the collisionless regime, where the mean free path of the thermal carriers is much greater than the channel diameter, allow a direct measurement of the carrier velocity. These experiments have been done using Vycor porous glass as the channel (average diameter ~ 70 Å) at temperatures down to 16 mK. They show that the carrier velocity (~43 m/sec) is that of quasiparticles rather than of bare ^{3}He atoms, whose velocity would be a factor of m^*/m (~3) greater, and thus confirm quite independently of any other measurement the validity of Landau quasiparticle theory. The data also strongly suggest a zero quasiparticle specular reflection coefficient, which allows an estimate to be made of the quasiparticle lifetime. This shows that the energy levels of quasiparticle states have a width more than ten times greater than kT at 20 mK. As an incidental result, a value for the low-temperature thermal conductivity of Vycor glass has been calculated. (auth)

1517 SUPERFLUIDITY IN LIQUID ^{3}He CONDENSATION IN THE L = 2 OR L = 3 STATE. Oestgaard, E. (Trondheim Univ., Norway). Physica; 71: No. 2, 415-422(15 Jan 1974).

The possibility of superfluidity in liquid ^{3}He is investigated, and the corresponding critical temperature is calculated or estimated. In the calculations are used reaction-matrix elements calculated earlier by means of Brueckner's theory. The results indicate that there is no superfluidity corresponding to S-state or P-state pairing in liquid ^{3}He. There is, however, probably superfluidity corresponding to D-state or F-state pairing. The largest transition temperature is obtained for L = 3, i.e., anisotropic superfluidity corresponding to the triplet F-state seems to be more likely than the singlet D-state pairing predicted earlier. Estimated critical temperatures for L = 3 are approximately 2.6 mK to 17.6 mK, while experimental results now indicate a value of 2.6 mK. For L = 2 critical temperatures of approximately 0.4 to 2.2 mK are obtained. Similar methods have also earlier predicted a too high critical temperature for liquid ^{3}He. (auth)

Superconductivity

Refer also to abstract 1514.

1518 A DENSITY-MATRIX FORMULATION OF THE HARTREE–FOCK–BOGOLIUBOV EQUATIONS FOR SPACE-DEPENDENT SUPERCONDUCTIVITY. Clinton, W. L. (Georgetown Univ., Washington, DC). Int. J. Quant. Chem., Symp.; No. 7, 479-489(1973).

From proceedings of the international symposium on atomic, molecular, and solid-state theory and quantum biology; Sanibel Island, FL (21 Jan 1973).

The Hartree–Fock–Bogoliubov equations that govern the quasiparticle states

$$\phi_n(\vec{r}) \equiv \begin{pmatrix} u_n(\vec{r}) \\ v_n(\vec{r}) \end{pmatrix}$$

of space-dependent superconductivity are formulated in terms of the pure state density matrices $\rho_n(\vec{r}',\vec{r}) \equiv \phi_n(\vec{r})\,\phi_n^{\dagger}(\vec{r})$. If

$$H(\vec{r}) \equiv \begin{pmatrix} H_N(\vec{r}) & 0 \\ 0 & -H_N^*(\vec{r}) \end{pmatrix} + \begin{pmatrix} 0 & \Delta(\vec{r}) \\ \Delta^*(\vec{r}) & 0 \end{pmatrix}$$

is the Hartree–Fock–Bogoliubov Hamiltonian where H_N is the normal metal part and $\Delta(\vec{r})$ the pairing potential, then the density operator equations are $[\rho_n, H] = 0$; $\rho_n^2 = \rho_n$; $\mathrm{tr}\,\rho_n = 1$. The pairing potential $\Delta(\vec{r}) = V\Sigma_n u_n(\vec{r})\, v_n^*(\vec{r}) \tanh(\beta E_n/2)$ is a mixed state quantity and, just as in the normal metal, the equations must be solved self-consistently. A steepest descent (optimum gradient) technique, developed by McWeeny for Hartree–Fock equations, is used to derive an iterative algorithm for solving the above equations. The formalism is developed in general for nonzero temperatures. The method is applied to the $T \approx T_c$ region. (auth)

1519 SEMICONDUCTORS AND SUPERCONDUCTORS BY SURFACE REFLECTION RAMAN SCATTERING. Evans, D. J.

Irvine, CA; Univ. of California (1973). 216p. University Microfilms Order No. 73-31,442.

Thesis (Ph.D.).

By means of surface reflection Raman scattering the dependence of the q = 0 TO and LO phonon line shapes as GaAs on surface preparation has been investigated. Polished surfaces have broad phonon lines compared to etched, annealed, or cleaved surfaces. It is believed that phonon lines are broadened by microscopic disorders generated during the polishing process. The temperature dependence of phonon lines in polished and annealed surfaces was studied and it was observed that the difference in phonon linewidths for these two surfaces is independent of temperature. It is therefore concluded that phonon lines are broadened by inhomogeneous strain, since increased anharmonic decay depends explicitly on temperature. It was estimated that the magnitude of the stress in polished surface layers is about 6×10^9 dynes/cm^2. It was found that doped GaAs samples have phonon lines which are identical to those in similarly prepared surfaces in undoped GaAs. The width of the depletion layer in doped GaAs depends on the techniques used to prepare the surface. The first Raman measurements on thin GaAs films epitaxially grown on sapphire are reported. The GaAs phonon lines observed by backscattering from the interface and the film have the same linewidths, suggesting that the lattice mismatch between (111) GaAs and (0001) Al_2O_3 does not contribute much strain induced broadening to the phonon spectra. By light scattering in the forward direction a surface polariton mode at the GaAs/Al_2O_3 interface has been observed at different scattering angles. An attempt has been made to detect light scattering from electron pairs in a thin film superconductor. Negative results are reported for the experiment, and an upper limit for the scattering efficiency has been determined. New experimental techniques in light scattering have been employed. (Diss. Abstr. Int., B)

1520 LATTICE INSTABILITIES AND SUPERCONDUCTIVITY OF (Hf, Zr)V_3 COMPOUNDS. Takashima, T.; Hayashi, H. (Kobe Steel Ltd., Japan). Phys. Lett.; 47A: No. 3, 209-210(25 Mar 1974).

The temperature dependences of the sound velocity of the pseudobinary (Hf, Zr)V_3 compounds show the evidence of lattice instability. The inverse relation between the superconducting transition temperature and the deduced transformation temperature is shown. (auth)

1521 RESISTIVE TRANSITIONS OF SUPERCONDUCTING THIN FILMS IN STRONG ELECTRIC FIELDS. Monceau, P. (Univ. of Southern California, Los Angeles). Phys. Lett.; 47A: No. 3, 193-194(25 Mar 1974).

Discontinuous current-induced transitions to the normal state of superconducting thin films in the mixed state are reported. The results obtained are in qualitative agreement with the recent theory of Thompson and Hu of dynamic instabilities of vortices. (auth)

1522 POSSIBLE SUPERCONDUCTIVITY AT ROOM TEMPERATURE. Antonowicz, K. (Univ. of Torun, Poland). Nature (London); 247: No. 5440, 358-360(8 Feb 1974).

It is stated that an anomalous current has been observed in Al/C/Al sandwiches, at room temperature, which in several respects behaves in the same way as the Josephson current might be expected to behave. In such sandwiches, subjected to proper electrical pulsing, changes in resistance by a factor of 10^3 were observed; the changes were reversible and showed a memory time of the order of a few days. The effect appeared to be complex and none of the models proposed for switching phenomena in amorphous materials was applicable. A striking observation was the strong dependence of the current on a small external magnetic field. Details are given for the preparation of suitable specimens, and the method of testing. Current-voltage curves were taken, and at about 2V it was found that an increase in current with time was indicated at constant or even decreasing voltage. This conductivity increase continued for 1 to 2 hours, and the final current was two to five times larger than at the beginning. The new state was quasi-stable and in good samples no significant decrease in conductivity could be detected for a few hours, although an appreciable decrease was evident after a few days. Above a certain voltage, however, further voltage increase caused a decrease in current, which was irreversible. The magnetic field was coil-produced, both the sample and the coil being located inside a Mu-metal cover that shielded the sample from the Earth's magnetic field. The dependence on the applied magnetic field is shown graphically. This strong dependence is known in tunneling between two superconductors. Mechanisms are discussed. A common feature of all the samples studied was a long relaxation time, and such long time constants are known to occur when deep electron traps are involved; in amorphous C a high concentration of such traps is known to be present. (UK)

1523 RELATION BETWEEN THE CRITICAL MAGNETIC FIELD AND ENERGY GAP OF A SUPERCONDUCTOR. Nowotny, H.; Grau, D.; Hittmair, O. (Technische Hochschule, Vienna). Phys. Lett.; 47A: No. 3, 245-246(25 Mar 1974).

A dynamical model is used to derive a relationship between the slope of the reduced critical magnetic field for $T = T_c$ and the energy gap Δ_0 of a superconductor. Good agreement with the relation $|dh/dt|_{t=1} = \Delta_0/kT_c$ proposed by Toxen is found up to $\Delta_0/kT_c = 4$. (auth)

1524 CRITICAL CURRENTS OF SUPERCONDUCTING ALLOYS WITH SPATIALLY-MODULATED CONCENTRATION. I. Effect of Period. Raffy, H.; Guyon, E.; Renard, J. C. (Paris Univ., Orsay, France). Solid State Commun.; 14: No. 5, 427-429 (1 Mar 1974). (In French).

A report is presented on the effect of the period of sinusoidal variations of concentration through the thickness of superconducting Pb–Bi films, on the critical current densities J_c as a function of an applied magnetic field H, perpendicular to J and parallel to the film plane. The existence of peaks on the J_c(H) curves suggests a matching effect between the vortex lattice and the modulation of concentration. (auth)

1525 THEORY OF SUPERCONDUCTIVITY FOR TRANSITION-METAL ALLOYS. Kerker, G.; Bennemann, K. H. (Freie Univ., Berlin). Solid State Commun.; 14: No. 5, 399-401(Mar 1974).

A theory of superconductivity for transition-metal alloys is presented by using the coherent potential approximation. Expressions for the superconducting order parameter and transition temperature of transition-metal alloys A_xB_{1-x} in terms of the parameters characterizing the pure metals are given. (auth)

1526 DAMPING OF FLUX JUMPING BY FLUX-FLOW RESISTANCE. Kremlev, M. G. (Inst. of High Temperature, Moscow). Cryogenics; 14: No. 3, 132-134(Mar 1974).

An equation to analyze the stability of a non-ideal type-II superconductor with respect to magnetic flux jumping is proposed. It takes into account final electrical resistivity of a superconductor driven to the resistive state, which leads to some degree of damping of the flux jump. The case of a hollow superconducting cylinder is analyzed in which the effect of this damping, although rather small in other practical instances, can show an observable effect. (auth)

1527 CRITICAL CURRENTS OF SUPERCONDUCTING ALLOYS WITH SPATIALLY-MODULATED CONCENTRATION. II. Effect of Temperature. Raffy, H.; Guyon, E.; Renard, J. C. (Paris Univ., Orsay, France). Solid State Commun.; 14: No. 5, 431-433(1 Mar 1974). (In French).

The peak effect observed in the variation of the critical current as a function of the magnetic field H of periodically inhomogeneous superconducting films is observed only below a characteristic temperature T* given approximately by $2\xi(T^*, \bar{C}) = 2a$ where 2a is the period of the modulation and $\bar{C}$ the mean concentration. The variation of the field values at peak J_c(H) as a function of temperature is described for Pb–Bi films. (auth)

1528 SUPERCONDUCTING CRITICAL TEMPERATURE, T_c, AND PHASE EQUILIBRIUM DIAGRAM OF A_3B (β–W) TYPE COMPOUNDS. Wang, F. E. (Naval Ordnance Lab., Silver Springs, MD). J. Phys. Chem. Solids; 35: No. 2, 273-278(Feb 1974).

A correlation between the superconducting critical temperature T_c, and solid solution range (SSR) appearing in the phase equilibrium diagram of A_3B (β–W) type compounds has been observed. Among the compounds of incongruent melting (peritectic or peritectoid) type, the T_c is directly proportional to the solid solution range. Further, in the low temperature range, the solid solution range invariably is found on the A element-rich side of the stoichiometric composition (75 at.% A: 25 at.% B), suggesting a fundamental importance in the "A-chain integrity" (viz, an A element can substitute for a B element which is not a part of the chain, but a B element cannot replace an A element which forms a part of the chain) which is believed to be a key to superconductivity. (auth)

1529 RECTIFICATION AND RECTIFICATION REVERSAL OF THE SURFACE CRITICAL CURRENT IN TYPE II SUPERCONDUCTORS IN THE MIXED STATE. Melville, P. H.; Das Cupta, A. (Univ., Goettingen, Ger.). Phil. Mag.; 29: No. 2, 275-284(Feb 1974).

A theory was developed to explain the values of the transport currents that can flow in very smooth single surfaces of some type-II superconductors, such as in specimens with a triangular cross section. The combined effect of the surface pinning, the surface barrier, and the Meissner currents was used to calculate the critical values for the transport currents. This dealt with

surface rectification, and in particular provided an explanation for rectification reversal, and the blunting of the angular dependence of the transport current under conditions of rectification reversal. The effects were of the correct magnitude to explain the experimental results. (auth)

1530 NONBRANCHING INTERMEDIATE-STATE STRUCTURES IN BULK LEAD. Kiendl, A.; Kirchner, H. (Siemens AG, Munich). J. Low Temp. Phys.; 14: No. 3-4, 349-363(Feb 1974).

By means of the magnetooptical method the intermediate-state structures of annealed polycrystalline lead foils having thicknesses between 40 and 120 μm have been investigated. The structures in increasing and decreasing magnetic field are qualitatively described. They mainly have laminar character, but above a critical thickness d_c, between 115 and 169 μm for T = 4.2 K, structures are found which can be interpreted by branching of the normal domains. Rapid increasing of the applied magnetic field at the $(\delta l)_T$ transition favors the formation of macro flux lines. The period of laminar structures shows good agreement with the "nonbranching" model of Landau for values of the reduced applied magnetic field $h = H/H_c \leq 0.6$. A value of the surface energy parameter $\Delta = 86 \pm 17$ nm is calculated from the experimental data. In contrast to the model of Goren and Tinkham, the mean separation of macro flux lines in lattices of flux lines is proportional to $1/\sqrt{h}$ for not too large values of h. (auth)

1531 DIFFUSIONLIKE EQUATION FOR SUPERCONDUCTING BINARY ALLOYS. Leung, M. C. (Institut Max von Laue Paul Langeevin, Garching, Ger.). J. Low Temp. Phys.; 14: No. 3-4, 373-385(Feb 1974).

A diffusionlike equation is derived within the coherent potential approximation (CPA) for type-II (or inhomogeneous), superconducting binary alloys. Diagrammatic formulation of the CPA is employed to extend the derivations of Eilenberger and Usadel to nondilute random substitutional alloys $A_{1-x}B_x$ having arbitrary concentrations and scattering strength. The generalized diffusion coefficient satisfies a simple algebraic equation, the coefficients of which are connected to measurable physical quantities. The diffusionlike equation is valid for arbitrary values of the order parameter at arbitrary temperatures below T_c. When the order parameter Δ is small, simple expansions in terms of Δ would lead immediately to the generalized Landau-Ginzburg equations. The upper critical magnetic field and magnetization are expressed as functions of concentrations of the binary alloy. (auth)

1532 SEARCH FOR SUPERCONDUCTORS ABOVE 20 K. Leger, J. M. (CNRS, Bellevue, France). J. Low Temp. Phys.; 14: No. 3-4, 297-316(Feb 1974).

The transition temperatures of cubic superconductors which have the same mean electronic concentration appear to be directly related to the lattice constants. The four cubic structures A15, B1, A12, and D5c have been examined. The effects of variations of the lattice constant and of the electronic concentration are clearly separated and many effects such as alloying can be accounted for. It is also possible to define the conditions required for compounds in each particular structure to have higher transition temperatures. The fabrication of some compounds is proposed and the necessity of making ternary compounds is outlined. The effects of rapid-quench techniques are shown to lead to a spreading of the superconducting transitions toward the lower or higher temperatures depending on the value of the electronic concentration. For the tetragonal D8b structure it appears that, in contrast with the cubic structures, the volume of the lattice cell is not an important factor: instead, the ratio of the crystalline parameters is. Unfortunately, due to the lack of available experimental data, only one noncubic structure could be examined. (auth)

1533 PROPERTIES OF SELECTED SUPERCONDUCTIVE MATERIALS. Roberts, B. W. National Bureau of Standards Technical Note 643. Washington, DC; National Bureau of Standards (1972). 96p. GPO $1.00.

This is a noncritical compilation of data on superconductive materials that have been extracted from the literature published up to early 1971. The properties concerned are composition, critical temperature, critical magnetic fields, crystallographic data, and the lowest temperature tested for materials specifically explored for superconductivity. The compilation also includes a bibliography, a list of general review articles, and a special tabulation of high magnetic field superconductors. (auth)

1534 SUPERCONDUCTORS WITH CRYSTALLINE-FIELD-SPLIT IMPURITIES: TUNNELING DENSITY OF STATES. Holzer, P. (Univ., Regensburg, Ger.); Keller, J.; Fulde, P. J. Low Temp. Phys.; 14: No. 3-4, 247-256(Feb 1974).

The tunneling density of states for superconductors containing rare earth impurities with crystal-field-split energy levels was computed. It is shown in detail how the different energy levels show up in the density of states. For the case of a singlet ground state it is demonstrated that the density of states curve is of the BCS type instead of the broadened Abrikosov-Gorkov type even if the pair-breaking effect of the impurities is strong enough to lower the superconducting transition temperature considerably. The tunneling conductance was also calculated in order to facilitate a comparison between theory and possible experiments. (auth)

1535 LANDAU DOMAIN STRUCTURE IN SUPERCONDUCTING ZINC. Wolf, B.; Gubser, D.; Farrell, D. E. (Naval Research Lab., Washington, DC). Solid State Commun.; 14: No. 6, 457-459 (15 Mar 1974).

Experimental data are reported for the dependence of the periodicity of the Landau domain structure in zinc on the fraction of the sample surface in the normal state. The data show good agreement with a modified form of the Landau-Sharvin Theory. (auth)

1536 LOCALIZED PHONONS IN THALLIUM-INDIUM BY SUPERCONDUCTIVE TUNNELING. Granqvist, C. G.; Claeson, T. (Chalmers Tekniska Hoegskola, Goeteborg). Solid State Commun.; 14: No. 6, 517-519(15 Mar 1974).

Phonon induced structure in superconductive tunneling curves indicates the existence of localized modes due to light in impurity atoms dissolved in Tl. Their frequencies are higher than the cutoff phonon frequency in pure Tl but slightly lower than expected from mass-defect theory. (auth)

1537 ELECTRONMICROSCOPIC EVIDENCE FOR A COLUMNAR-VOID-TYPE STRUCTURE IN SPUTTERED NbN FILMS. Wagner, W.; Ast, D. (Cornell University, Bard Hall, Ithaca, New York 14850); Gavaler, J.R. J. Appl. Phys. 45: No. 1, 465-466 (Jan 1974).

Transmission electron microscopy of sputtered NbN films shows that the films contain columnar grains with an average axial diameter of 100 A or less. A large number of narrow ($\simeq$ 20 A) voids separate most of the grains. The voids extend through the film and are probably responsible for the strong pinning observed in these films. The high resistivity and relatedly the high upper critical field values of the films are also believed to be due to this columnar-void structure. (auth)

1538 CURRENT-VOLTAGE CHARACTERISTICS OF SUPERCONDUCTING TUNNEL JUNCTIONS. Stewart, W.C. (RCA Laboratories, Princeton, New Jersey 08540). J. Appl. Phys. 45: No. 1, 452-456 (Jan 1974).

The lumped equivalent circuit model of a superconducting tunnel junction with a voltage-dependent normal conductance current represented by $I_r = I_0(V/V_0)^n$ is analyzed for the cases n = 2 and $n \to \infty$. Analytic expressions for the hysteresis parameter as a function of the damping factor are obtained. The time-averaged voltage-current characteristics for n = 2 are given in closed form. The results are qualitatively similar to the linear conductance case where n = 1, but the hysteresis is more pronounced for larger n. (auth)

1539 PREPARATION AND HIGH-FIELD SUPERCONDUCTING PROPERTIES OF VAPOR-DEPOSITED Nb_3Sn ALLOYS. Enstrom, R.E.; Appert, J.R. (RCA Laboratories, Princeton, New Jersey 08540). J. Appl. Phys. 45: No. 1, 421-428 (Jan 1974).

Nb_3Sn alloyed with Si, Ti, V, Ta, Bi, or Mo has been grown from the vapor phase on stainless-steel (Hastelloy) ribbon substrates. Compared to a value of 185 kOe observed for unalloyed Nb_3Sn, 1.3% Si increased H_{c2} to 225 kOe, while 0.002% Bi or 0.05% V raised H_{c2} to about 215 kOe. Whereas 0.0006% Ti or 3.7% Ta did not affect H_{c2} appreciably, 0.4% Mo decreased H_{c2} to 140 kOe. Diffusion of Ni from the stainless-steel substrate into the Nb_3Sn layer appears to be responsible for the observed H_{c2} value of 196 kOe for the unalloyed (but carbon doped) ribbon since the same Nb_3Sn layer on a Nb substrate has an H_{c2} value of 225 kOe. The effect of the Ni outdiffusion on H_{c2} can be reduced by reducing the Nb_3Sn growth temperature or by increasing the Nb_3Sn layer thickness. H_{c2} does not appear to correlate directly with T_c since T_c is about 15.5 °K for both the Si- and Mo-alloyed Nb_3Sn, as well as for the unalloyed Nb_3Sn deposited on a Nb substrate, while H_{c2} ranges from 140 to 225 kOe. The intermediate phase region between the Nb_3Sn layer and the stainless-steel substrate consists of a rich variety of phases including NbNi, $NbNi_3$, Ni_3Sn, Ni_3Sn_2, and MoNi. Alloying Nb_3Sn with Bi, Ti, V, and Mo reduces J_c by a factor of 2 to 4 compared to the unalloyed sample. Ta does not significantly affect J_c and Si significantly increases J_c above 120 kOe. CO_2 or C_2H_6 additions can increase J_c for the alloy ribbons by up to a factor of 8, but not to values greater than observed for unalloyed Nb_3Sn doped with carbon. Si alloys doped with carbon are an exception and have higher J_c values above 120 kOe than the carbon-doped unalloyed ribbon. (auth)

1540 CURRENT INJECTION AND COLLECTION IN A RECTANGULAR SUPERCONDUCTOR. Moreno, H.; Rabinowitz, M. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). J. Appl. Phys. 45: No. 1, 410-413 (Jan 1974).

A general two-dimensional analytical solution is presented for the problem of transport current injection from a normal conductor into a superconductor and collection back into a normal conductor. The current distribution is solved for the general case which takes in the full range from essentially point source to full-width injection and collection. The current distribution also represents that in a split-ring superconductor joined by a link of variable width, such as that in a Josephson junction. A comparison is made with current injection into and collection from a normal conductor. Computer calculations are included showing a virtual anomaly which is reconciled. Speculation is made regarding the formation of transport current vortices in an initially simply connected superconductor. (auth)

1541 FLUX KINETICS AND HEAT FLOW DURING FLUX JUMPS IN TYPE-II SUPERCONDUCTORS. Harrison, R.B.; Wright, L.S. (Royal Military College of Canada, Kingston, Ontario, Canada); Wertheimer, M.R. J. Appl. Phys. 45: No. 1, 403-409 (Jan 1974).

The Faraday-rotation technique in combination with high-speed cinephotography has been used to study flux kinetics and heat flow associated with flux jumps in type-II superconductors. It has been shown that at "runaway" velocities, flux motion can be better described in terms of an exponential rather than a diffusion law. Transients observed to exist in the flux-penetrated region and thought to represent a flux relaxation or redistribution following the jump have been shown to be associated with heating effects in the Faraday glass. Heat flow and its relationship to the flux kinetics was studied for the particular case of a Nb-25%Zr disk sample at 1.4 K in different thermal environments; that is, in a vacuum or immersed in liquid-helium II. In the latter case, heat transfer to the bath was about three orders of magnitude more important than thermal conduction within the sample. Nevertheless, the assumption that flux jumps take place under essentially adiabatic conditions, made for purposes of analysis, turns out to be approximately correct; this supports the theoretical treatments of Swartz and Bean and Wipf. (auth)

1542 SUPERCONDUCTIVITY IN SOME NEW METASTABLE FILM PHASES. Testardi, L.R.; Wernick, J.H.; Royer, W.A.; Bacon, D.D.; Storm, A.R. (Bell Laboratories, Murray Hill, New Jersey 07974). J. Appl. Phys. 45: No. 1, 446-451 (Jan 1974).

The occurrence of new metallurgical phases and enhanced superconductivity in a number of sputtered transition-metal alloy films has been studied as a function of substrate temperature during deposition. Results indicate that such new phases are readily produced in the temperature range 200-1000 °C by this technique and that these new phases are accompanied by marked changes in the superconducting transition temperature. The findings show how easily the more complex transition-metal alloys, particularly σ phase, can be modified at low temperatures, and demonstrate the importance of structural instability, vis-à-vis composition, in determining the superconducting transition temperature. (auth)

1543 ELECTRONICALLY ATYPICAL A15-TYPE COMPOUNDS BASED ON CHROMIUM AND MOLYBDENUM. Flukiger, R.; Paoli, A.; Muller, J. (Univ., Geneva). Solid State Commun.; 14: No. 6, 443-447(15 Mar 1974).

The superconducting transition temperature was investigated as a function of composition and degree of long-range order in a number of binary and ternary A15-type phases based on Cr and Mo. It is concluded that these compounds are unlike the typical Nb- or V-based phases with the same structure. The maximum T_c does usually not occur at the ideal composition. Nevertheless, a correlation was found between T_c and the degree of order. (auth)

Equipment and Devices

1544 75 kG 41 cm BORE CONTINUOUS DISK WOUND NbTi SUPERCONDUCTING MAGNET. Atherton, D. L.; Stevenson, R. (Queen's Univ., Kingston, Ont.). Cryogenics; 14: No. 3, 164-166 (Mar 1974).

The design, construction, and testing of a large NbTi superconducting solenoid wound by a new technique to allow the convenient insertion of internal cooling passages is described. This particular solenoid is the outermost section of a high field hybrid magnet. (UK)

1545 DIAMETER OF SUPERCONDUCTING FILAMENTS IN MULTIFILAMENTARY WIRES REQUIRED FOR STABILITY AT DIFFERENT TEMPERATURES. Lange, F.; Verges, P. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Cryogenics; 14: No. 3, 135-138(Mar 1974).

Using superconducting NbTi magnets it is possible to generate fields up to 12 T maximum, if intrinsically stable material is used, at 1.5 K. The filament diameters required to ensure intrinsic stable behavior and their dependence on temperature are presented. At the highest current density so far reached the maximum permissible diameters are 130 μm at 4.2 K and 15 μm at 1.5 K. (auth)

1546 FUTURE TRENDS IN ELECTRICITY GENERATION. Hawley, R. (Parsons (C.A.) and Co. Ltd., Newcastle Upon Tyne, Eng.). Electron. Power; 20: No. 4, 134-139(7 Mar 1974).

Among a number of possible methods for the future generation of electricity, the author mentions the idea of using β particles, i.e., electrons from a radioactive source, to charge up an isolated electrode. An alternative method using alpha particles, i.e., helium nuclei, to generate power is also considered. Present studies indicate that both these devices will be limited to lower power output devices and that they are unlikely to be used for base-load power generation. However, in view of the various constraints on the methods discussed, the proven record of the conventional turbogenerator and the vast development and manufacturing costs already dedicated and earmarked for this method, one can only conclude that turbogenerators will continue to be the base-load power-generating device. Two questions then arise: What will be the size of a single unit? What form will the construction of the electrical generator take? In the following discussion the possible use of superconducting techniques to cool the rotor windings thereby dispensing with the need for large amounts of iron laminates to carry the magnetic flux is considered. Reviewing the future prospects for superconducting generators it is concluded that a large superconducting generator will have a power density of 3:1 in comparison with a conventional generator, so that, together with certain other advantages, this concept is a very likely contender for a 2000 MW machine. (UK)

1547 CHARACTERISTICS OF A SUPERCONDUCTING POINT CONTACT AS A RADIATION DETECTOR. Divin, Yu. Ya.; Nad, F. Ya. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 18: No. 4, 642-644(Apr 1973).

Translated from Radiotekh. Elektron.; 18: No. 4, 879-881 (Apr 1973).

A superconducting point contact (SPC) has a high sensitivity to millimeter and submillimeter radiation, and therefore it is very promising for use as the sensitive element of a wide-band receiver in this band. The change in the I-V characteristic (IVC) of an SPC due to the action of radiation has previously been investigated theoretically and experimentally, however, the conditions for obtaining optimum photoresponse were not studied, and its spectral dependence has received little attention up to now. The results of a study of the features of various types of IVC's, a study of the optimum conditions for obtaining high sensitivity, and a study of its spectral distribution in the 5-30 cm^{-1} frequency interval are presented. (auth)

1548 MEASUREMENT OF rf POWER AND ATTENUATION USING SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES. Kamper, R. A.; Simmonds, M. B.; Hoer, C. A.; Adair, R. T. National Bureau of Standards Technical Note 643. Washington, DC; National Bureau of Standards (1973). 93p. GPO $1.00.

The first two years' work on a project to exploit an entirely new principle for the measurement of rf power and attenuation, namely the Superconducting Quantum Interference Device (SQUID), is summarized. This is a simple circuit of superconducting metal, operating at a very low temperature in a bath of liquid helium. It functions as a sensor of magnetic flux with an almost perfectly periodic response over a wide dynamic range. It may therefore be used to measure dc or rf electrical quantities such as current, power, attenuation, etc., in circuits inductively coupled to it. Measurements of these quantities can be made by counting off periods in the response of the SQUID (flux quanta) in the same way that length is measured with a laser by counting off wavelengths of light. Prototype systems for measuring power and attenuation as accurately as one can test by the conventional means available were developed and tested. A single calibration with dc is required to measure absolute rf power in the range of frequency from 0 to 1 GHz at levels from 10^{-6} W to 10^{-3} W with an uncertainty of ±0.1 dB at the port of the SQUID. Transferring this measurement to calibrate a source of power would require a proper evaluation of the intervening network over the full range of frequency. The feasibility of extending the measurements of power to much lower levels was demonstrated. No external calibration is required to measure rf attenuation directly over a dynamic range of 45 dB with an rms deviation of ±0.002 dB from calibrations performed by the NBS Calibration Service. After an elementary exposition of the basic principles of the technique, the following are described: the SQUIDs themselves; the prototype systems developed to measure rf power and attenuation; systematic errors and fundamental limitations of the measurements that can be performed with them; and the obvious and immediate im-

provements that can be applied to them. An appendix is reserved for detailed drawings and instructions for the fabrication of components. Material from previous reports is included. (auth)

1549 SVERKHPROVODIASHCHIE VOLNOVODY I REZONATORY. (Superconducting Waveguides and Resonators). Didenko, A. N. Moscow; Izdatel'stvo Sovetskoe Radio (1973). 256p.

A number of problems are considered which are related to electromagnetic-wave propagation in superconducting waveguides and to the excitation of vibrations in superconducting resonators. Results are presented on wave propagation in smooth and iris waveguides, and the basic structural features of such waveguides during operation at low and high power levels are analyzed. Problems in measuring the electrodynamic parameters of superconducting microwave systems are considered, as well as the fabrication of such systems. Particular attention is paid to the calculation of the gain coefficient of traveling-wave superconducting resonators and to problems of particle motion in superconducting waveguides and resonators. Data are presented which make it possible to determine the maximum efficiency of such systems. The possible ranges of applicability of superconducting waveguides and resonators are determined. (IAA)

1550 USING THE SEMICONDUCTOR JUNCTION IN QUANTUM INTERFERENCE DEVICES. Simmonds, M.B. (Cryogenics Division, National Bureau of Standards, Boulder, Colorado). J. Appl. Phys. 45: No. 1, 366-368 (Jan 1974).

We have fabricated small-area tunnel junctions of a lead–tellurium–lead structure. These have been used in conjunction with bulk superconductors to make hybrid quantum interference devices. We have successfully operated these devices at bias frequencies of 30 MHz, 300 MHz, and 10 GHz. (auth)

1551 DIFFRACTION PATTERNS AND VORTEX STRUCTURE OF ASYMMETRICAL AND CROSS JOSEPHSON JUNCTIONS. Stuehm, D.L.; Wilmsen, C.W. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80521). J. Appl. Phys. 45: No. 1, 429-433 (Jan 1974).

The critical current of an asymmetrical Josephson junction as a function of magnetic field has been computed for junction lengths of $2\lambda_J$ and $6\lambda_J$. The boundary conditions for the asymmetrical and cross junction (with an assumed current distribution) are derived. Similarity between the computed asymmetrical junction diffraction patterns and experimental patterns for the cross junction plus identical boundary conditions indicate that the current flow in the cross junction is the same as in the asymmetrical junction. Profiles of the current density in the linear and asymmetrical Josephson junctions are compared. (auth)

1552 TUNNELING IN LEAD–LEAD OXIDE–LEAD JUNCTIONS. Basavaiah, S.; Eldridge, J.M.; Matisoo, J. (IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598). J. Appl. Phys. 45: No. 1, 457-464 (Jan 1974).

A detailed investigation of tunneling in Pb/PbO/Pb junctions has been carried out, in an attempt to independently measure several of the parameters known to enter the tunneling problem. In particular, the thickness of the tunnel barrier (orthorhombic PbO thermally grown *in situ* in an ultraclean vacuum system) has been measured ellipsometrically, and barrier heights of 1.15 ± 0.15 eV at both metal-oxide interfaces have been deduced from Fowler-Nordheim plots and logarithmic conductivity measurements. The junctions are of high quality (less than 0.1% nontunneling currents) and cover a Josephson current density range of from 10^{-4} to 10^{3} A/cm^2. From the dependence of the current density on the barrier thickness, an effective mass ratio, m^*/m of 0.5 ± 0.1 has been deduced for electrons in the barrier. Comparison of experimental results with the tunneling theory shows that to obtain an agreement between them, image-force corrections must be neglected. Reasonable quantitative agreement has been obtained with a small correction of 4–5 Å to the ellipsometric thickness values in the range 19–31 Å; no other adjustments are found necessary. This discrepancy might be attributed to a difference between ellipsometric and tunneling thickness values. (auth)

PHYSICS (NUCLEAR)

1553 (CONF-721231-PA) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, CHANDIGARH, INDIA, DECEMBER 28, 1972–JANUARY 1, 1973. Volume 15 A: Invited Talks. (Department of Atomic Energy, Bombay (India). Physics Committee). 1972. 235p.

The invited papers presented at this conference were divided into four sections: Seminar on physics with low-energy accelerators, Seminar on physics with lasers, Nuclear physics, and Solid state physics. Although this volume contains the texts of only the invited papers, all of the papers presented are listed by title. Separate abstracts were prepared for seven of the papers in this volume. (RWR)

For abstracts of individual papers see: 409, 763, 935, 1270, 1554, 1555, and 1681.

1554 (CONF-721231-PA, pp 49-52) NUCLEAR PHYSICS RESEARCH WITH LOW ENERGY ACCELERATORS. Mehta, G. K. (Indian Inst. of Tech., Kanpur). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

Areas in which low-energy accelerators play important roles in providing knowledge of the static and dynamic properties of nuclear levels are mentioned. Three discussed in greater than average detail are nuclear astrophysics, spectroscopy of analog states, and fission studies for $E_n > 50$ keV. (RWR)

1555 (CONF-721231-PA, pp 91-124) DETERMINATION OF ULTRASHORT NUCLEAR LIFETIMES BY BLOCKING TECHNIQUE. Nielsen, K. O. (Univ. of Aarhus, Denmark). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

An evaluation of the blocking technique and its importance for compound-nucleus reaction studies in the lifetime range from 10^{-18} to 10^{-15} seconds is given. The basic principles of the measurement are first described. The decrease in cross section due to blocking can be characterized in several ways: change in minimum yield, change in half-width at half dip, the planar defect, and the "donut" effect. The crystal-blocking lifetime technique is then compared with other methods; and some technical improvements relating to detectors, crystal technique, and goniometers are described. Finally, some typical lifetime experiments are discussed; these include the following: monoenergetic neutron fission, heavy-ion fission in heavy elements, lifetimes of highly excited nuclei formed by bombardment of Ni and Co crystals, and single nuclear levels excited in (p,α) resonance reactions on Al. (12 figures) (RWR)

Neutron Interactions with Matter

1556 (AD-769712) SENSITIVITY OF THE TRANSPORT OF 14-MeV NEUTRONS TO THE NITROGEN–ELASTIC ANGULAR DISTRIBUTION. Beverly, W. B. (Ballistic Research Labs., Aberdeen Proving Ground, Md. (USA)). Sep 1973. 76p. (BRL-1666). NTIS $3.75.

Calculations have been made to determine the radiation fields that would be generated by the transport of 14-MeV neutrons from a monodirectional point source in uniform nitrogen using two different cross section sets. One set was compiled from the ENDF/B Round-2 nuclear data file. The other set was compiled from the same ENDF/B Round-2 file; however, the shape of the elastic angular distribution was replaced by that of the ENDF/B Round-1 angular distribution. The correlated-sampling, Monte-Carlo, neutron-transport code SAMCEP was used for the calculations in order to facilitate more meaningful comparisons between the calculated answers of the two problems. (GRA)

1557 (COO-3058-44) LINEAR ACCELERATOR PROJECT. Progress Report, October 1–December 31, 1973. Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y. (USA)). [nd]. Contract AT(11-1)-3058. 20p. Dep. NTIS $4.00.

Work on experimental and theoretical aspects of reactor physics and engineering and neutron cross sections is reported. Papers with significant amounts of data are separately title listed. (RWR)

For title listings of individual papers see: 1558 and 1666.

1558 (COO-3058-44, pp 14-18) REACTOR THEORY AND ANALYSIS. Becker, M. [nd].

In linear accelerator project. Progress report, October 1–December 31, 1973.

1559 (FEI-392) ACCOUNT FOR SELF-SHIELDING EFFECTS IN REACTIVITY COEFFICIENT MEASUREMENTS. Dulin, V. A.; Mamontov, V. F. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1972. 24p. (In Russian). INIS.

Methods for the computation of the self-shielding effects of samples during measurement of reactivity coefficients were described. The methods for the computation of the self-shielding for absorbing, fissioning, and scattering materials were examined. Attenuation of the group flux in the samples was calculated in the Wigner approximation with resonance absorption taken into account. The results of the calculation of the dependence of the reactivity coefficient of U, Pu, Au, Ta, B, graphite, and hydrogen on the sample dimensions were reported. The calculations were compared with experimental results. (tr-auth)

1560 DIRECT CALCULATION OF THE TIME-DEPENDENT SPATIAL MOMENTS OF THE ONE-SPEED NEUTRON TRANSPORT MODEL. Ganapol, B. D. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Sci. Eng.; 53: No. 3, 350-351(Mar 1974).

It is shown that time-dependent spatial moments can be obtained from the Case–Zweifel solution to the one-speed transport equation in plane, spherical, or cylindrical geometry. Some numerical results facilitating the moments calculation are also presented. (JWR)

1561 SOLUTION OF STANDARD DIAMOND DIFFERENCE EQUATIONS FOR DISCRETE-ORDINATE NEUTRON TRANSPORT EQUATIONS EQUIVALENT TO THE P_L APPROXIMATION IN x–y GEOMETRY. Jung, J.; Ohtani, N.; Kobayashi, K.; Nishihara, H. (Kyoto Univ.). Nucl. Sci. Eng.; 53: No. 4, 355-369(Apr 1974).

Discrete-ordinate neutron transport equations in x–y geometry, which are equivalent to the P_L approximation, are developed for eliminating the ray effect in the usual discrete-ordinate or S_N method. The standard diamond difference schemes for the discrete-ordinate equations developed here are studied for vacuum and periodic boundary conditions. It is shown that the difference schemes, with an exception, lead to nonsingular systems of algebraic equations. The exception, which yields singular systems of difference equations, is the case where the following condition is satisfied: "In at least one of the x and y directions, the boundary conditions are periodic, and the number of mesh intervals is even." It is also shown that the solutions yielded by these schemes with periodic boundary conditions converge in the L_2 norm to the solutions of the P_L equations. (2 figures, 1 table) (auth)

1562 SOLUTION OF TRANSPORT THEORY PROBLEMS WITH SPHERICAL GEOMETRY. Ershov, Yu. I.; Shikhov, S. B. Zh. Vychisl. Mat. i Mat. Fiz.; 13: No. 6, 1534-1543(1973). (In Russian).

For the solution of problems of the one-velocity neutron transport theory with isotropic scattering in spherical-symmetrical inhomogeneous medium the integral transform method was used. Functions were obtained having the sense of elementary solutions of the Boltzmann equations in spherical geometry. (tr-auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 1630, 1690, 1719, and 1724.

1563 (JINR-E4-7727) SINGULARITY SUBTRACTION METHOD FOR EXTRACTING SPECTROSCOPIC INFORMATION FROM NUCLEAR REACTION DATA. Borbely, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 12p. Dep. NTIS (U. S. Sales Only) $4.00.

An exact method is proposed for determining the strength of the nearest singularity of the differential cross section and thus getting information on the structure of nuclei in a completely model-independent way. Using this method the $t \rightarrow d + n$ vertex constant was determined with an impressively small error. The connection with similar methods is discussed. (auth)

1564 POLARIZATION OF DD NEUTRONS. Schmidt, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 720(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1565 TEST OF ISOSPIN CONSERVATION BY A COMPARISON OF $^3H(^3He, ^4He)^3H$ AND $^3He(^3He, ^4He)2p$, AT 16.0 MeV c.m. Roberts, W.J.; Gross, E.E.; Newman, E. (Oak Ridge

National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 9: No. 1, 149-155 (Jan 1974).

The absolute differential cross sections for the reactions (A) ^{3}H(^{3}He, ^{4}He)^{2}H and (B) ^{3}He(^{3}He, ^{4}He)2p have been measured at 16.0 MeV c.m. Using final-state interaction theory, we have extracted the cross section for leaving the diproton in the $^1S_0$ state for reaction (B). Conservation of isospin requires this cross section to have twice the magnitude and the same angular distribution as reaction (A). Isospin conservation also requires that reaction (A) be symmetric about 90 ° c.m. At 16.0 MeV c.m. we find deviations from 90 ° symmetry for reaction (A) which are consistent with lower-energy data. In addition, we report deviations from isospin conservation for the comparison test. However, using a simple single-nucleon-transfer model, we are able to qualitatively account both for the deviation from 90° symmetry for reaction (A) and for the deviation from the factor of 2 in the ratio of the yield of reaction (B) to that of reaction (A). (auth)

1566 BEHAVIOR OF THE THREE-NUCLEON SYSTEM WHEN THE TWO-NUCLEON INTERACTION IS VARIED. Doolen, G.; Jain, M.; Burnett, T. (Physics Department and Cyclotron Institute, Texas A & M University, College Station, Texas 77843). Phys. Rev. C 9: No. 1, 23-27 (Jan 1974).

The solution of the Faddeev equations for the three-nucleon system with separable s-wave two-nucleon interactions has been continued onto the second sheet where resonance poles would appear if any existed. No resonance poles were found in the regions searched where previous work has suggested the possible existence of resonances. When the two-nucleon coupling constants are weakened slightly, a virtual state in the triton system becomes bound in the ^{2}S channel. When the two-nucleon coupling constant is considerably strengthened, new resonances appear in the three-nucleon system. (auth)

1567 APPLICATION OF THE KOHN VARIATIONAL PRINCIPLE TO THREE-PARTICLE INELASTIC SCATTERING. Webb, J.G. (Department of Physical Science, University of Arkansas at Monticello, Monticello, Arkansas 71655). Phys. Rev. C 9: No. 1, 43-47 (Jan 1974).

We consider the problem of three spinless particles interacting by means of a central potential. The initial state is a free particle labeled number 1 incident on a bound state of particles 2 and 3 and with enough energy to create a three-free-particle final state. We calculate the S-wave elastic scattering amplitude both above and below the inelastic threshold using an extension of the Kohn variational principle suggested by Nuttall. For the asymptotic form, we use the simplest function available. The form used has been shown to be incorrect in certain regions of coordinate space. The trial function we use has up to 32 linear parameters and a range of values for a nonlinear parameter. Below breakup convergence is observed towards a unitary result, but in the inelastic region little evidence of convergence is present. (auth)

1568 ELASTIC SCATTERING OF NEUTRONS FROM ^{3}He BETWEEN 7.9 AND 23.7 MeV. Drosg, M.; McDaniels, D.K.; Hopkins, J.C.; Seagrave, J.D.; Sherman, R.H.; Kerr, E.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). Phys. Rev. C 9: No. 1, 179-187 (Jan 1974).

Neutrons of 7.9, 12.0, 13.6, 14.4, and 23.7 MeV were elastically scattered from a 0.54-mole sample of liquid ^{3}He. The angular distributions of the scattered neutrons were measured by the time-of-flight method at 14 angles ranging from $\cos\theta_{c.m.} = 0.9$ to -0.7 with relative errors of typically 4%. The absolute values were derived by comparison with the ^{1}H(n, n)^{1}H reaction with scale errors of about 3%. Many of the older distributions and total n-^{3}He cross sections in this energy range are superseded by the new measurements. Upper limits for the ^{3}He(n, np)^{2}H + ^{3}He(n, 2n)2p cross-sections sum are derived. The differential cross sections at 7.9, 13.6, and 14.4 MeV are compared with their charge-symmetric counterpart at nearby energies. The contribution of this experiment to phase-shift analysis of the ^{3}He(n, n)^{3}He data is discussed. (auth)

1569 MICROSCOPIC COUPLED-CHANNEL STUDY OF THE FIVE-NUCLEON SYSTEM WITH THE RESONATING-GROUP METHOD. Chwieroth, F.S.; Tang, Y.C.; Thompson, D.R. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. C 9: No. 1, 56-68 (Jan 1974).

A coupled-channel study of the five-nucleon system is performed with the resonating-group method. The channels which are explicitly considered are the d + ^{3}He (or d + ^{3}H) and the p + α (or n + α) channels. Three- and more-body breakup channels are not included in the calculation, but their effects are crudely taken into account by the introduction of phenomenological imaginary potentials into the formulation. The nucleon-nucleon potential used is purely central, but does yield correct values for the two-nucleon effective-range parameters. Differential scattering and reaction cross sections are calculated at various energies. The result shows that for the d + ^{3}He and p + α differential scattering cross sections, the calculated values in general agree quite well with the experimental data. For the d + ^{3}He ⇒ p + α differential reaction cross sections, the comparison between theory and experiment is somewhat less satisfactory. Although the general features of the experimental angular distributions are well reproduced, the magnitude of the calculated cross section is somewhat too low. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 1616, 1706, 1708, and 1725.

1570 INELASTIC PROCESSES IN THE ^{19}F(^{3}He,d)^{20}Ne REACTION. Vertse, T.; Dudek-Ellis, P. J.; Belote, T. A.; Roaf, D. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A223: No. 1, 207-220(1974).

The role of inelastic processes in the ^{19}F(^{3}He,d)^{20}Ne reaction was examined. By coupling three levels in both the entrance and exit channels it was found that the inelastic processes were able to account for both the magnitude and rather flat shape of the angular distribution for the 4.25 MeV 4$^+$ level observed in the ^{19}F(^{3}He, d)^{20}Ne reaction at 16 MeV bombarding energy. In contrast the DWBA could not account for the data. The magnitude of the inelastic processes was found to be quite sensitive to some of the optical model parameters involved. The DWBA predictions for the 0$^+$ and 2$^+$ cross sections were modified by the inelastic processes requiring some adjustment of the spectroscopic amplitudes to account for the data. (auth)

1571 CROSS SECTION AND VECTOR ANALYZING POWER FOR THE ELASTIC SCATTERING OF 15.0-MeV DEUTERONS FROM ^{10}B, ^{12}C, ^{13}C, ^{14}N, AND ^{16}O. Busch, C. E.; Clegg, T. B.; Datta, S. K.; Ludwig, E. J. (Univ. of North Carolina, Chapel Hill). Nucl. Phys.; A223: No. 1, 183-194(1974).

Angular distributions of the cross section and vector analyzing power have been measured for the elastic scattering of polarized 15.0 MeV deuterons from ^{10}B, ^{12}C, ^{13}C, ^{14}N and ^{16}O. The general features of the cross section σ/σ_R and analyzing power iT_{11} are reproduced by optical-model calculations obtained by fitting either cross-section and analyzing power data individually or by fitting the cross-section data and the product $(\sigma/\sigma_R)(iT_{11})$. The optical-model parameters obtained are seen to change in a consistent manner for the nuclei studied. (auth)

1572 SOLUTION OF THE GENERALIZED BETHE-GOLDSTONE EQUATION FOR ^{16}O. Schlitter, J. (Univ., Bochum, Ger.). Z. Naturforsch.; 28a: No. 10, 1586-1590(Oct 1973).

The generalized Bethe-Goldstone equation from the e^s-theory is used to perform a calculation in the harmonic oscillator model. It takes into account hole-hole diagrams and eliminates the model-dependent particle energies. Both effects tend to increase the binding energy and to decrease the nuclear radius. (GE)

1573 MICROSCOPIC NUCLEAR MAGNETIC MOMENT CALCULATIONS INCLUDING HARTREE-FOCK GRAPHS. Rifai Habbal, S.; Mavromatis, H. A. (American Univ. of Beirut). Nucl. Phys.; A223: No. 1, 174-182(1974).

All magnetic moment graphs which may be non-zero to second order for closed shell ±1 nuclei are tabulated. Their contributions to the magnetic moments of ^{11}B, ^{13}C, ^{13}N, ^{15}O, ^{15}N, ^{17}O, ^{17}F, ^{27}Al, ^{29}Si, ^{31}P and ^{33}S are calculated. For L-S ±1 nuclei Hartree-Fock graphs do not contribute to second order for central residual interactions (and are small otherwise), while for the j-j ±1 nuclei considered they are roughly as important as the non-Hartree-Fock graphs and of the same sign as the first-order corrections. Calculations were performed with the Kallio-Kolltveit and Sussex interactions. The procedures used to check the calculations are discussed. (auth)

1574 MULTINUCLEON CONFIGURATIONS IN LIGHT NUCLEI. Servo, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 84-87(Jan 1974). (In Russian).

The observed relation between the binding energy of neutrons of isotopes of identical parity was discussed for a series of light elements. A simple model was proposed for the explanation of this relation. (3 figures) (tr-auth)

1575 CALCULATION OF THE REACTION ^{3}He(e,e'p)^{2}H CROSS-SECTION WITH TAKING INTO ACCOUNT INTERACTION AT FINAL STATE. Tartakovskii, V. K.; Levshin, E. B. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 61-66(Jan 1974). (In Russian).

The cross section of ^{3}He nucleus two-particle electric disintegration is calculated at high relative energies of the reaction fragments, the interaction between them being taken into account. A diffraction approximation was used to describe this interaction. The obtained angular and energy distributions at high energies of the reaction products relative movement are also strongly dependent on the interaction at the final state. (auth)

1576 ROLE OF SYSTEMATICS IN NEUTRON DATA EVALUATION. Csikai, G. J. (Kossuth Univ., Debrecen, Hungary). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 711-712(1972).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1577 INVESTIGATION OF THE CAPTURE REACTION $^{15}N(p,\gamma_0)^{16}O$ IN THE CONTINUUM SHELL MODEL. Barz, H. W. (ZfK, Rossendorf, Ger.); Rotter, I.; Hoehn, J. Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 736-738(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1578 USE OF THE THICK-TARGET METHOD FOR MEASUREMENT OF THE ENERGY DEPENDENCE OF PROTON POLARIZATION DURING ELASTIC SCATTERING BY ^{12}C. Gulamov, I. R.; Romanovskii, E. A.; Spasskaya, T. I.; Goncharov, O. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 140-143(Jan 1974). (In Russian).

A procedure was proposed for the determination of the energy dependence of the proton polarization in a relatively large energy interval. The method is based on the use of thick targets as a scattering medium. (2 figures, 1 table) (tr-auth)

1579 ANALYSIS IN THE FRAMEWORK OF THE OPTICAL MODEL OF THE ELASTIC SCATTERING CROSS SECTION AND POLARIZATION OF PROTONS ON ^{9}Be. Gubin, V. B.; Romanovskii, E. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 144-148(Jan 1974). (In Russian).

The elastic scattering of protons on ^{9}Be at E_{lab} from 5 to 12 MeV was analyzed by fitting the polarization curve, calculated by the optical model, to experiments. The calculations indicated that the resonance in the d waves at $E_{lab} = 4.7$ MeV has $j = 5/2$ and small elastic width. (2 figures, 4 tables) (tr-auth)

1580 LEVELS IN ^{14}N AND ^{13}C IN THE REACTION $^{12}C(d,p)^{13}C$. Gmuer, K.; Mueller, H. H. (Univ., Zurich). Helv. Phys. Acta; 46: 807-823(1974). (In German).

Levels in ^{14}N between 11.81 and 12.41 MeV were investigated by means of the $^{12}C(d,p)^{13}C$ reaction ($E_d = 1.82$ to 2.50 MeV). From angular distributions measured at 40 keV intervals levels at 11.92, 12.05 and 12.25 MeV with widths of 0.07, 0.19 and 0.30 MeV respectively are deduced. Reasonable agreement is obtained between the data and calculated cross sections based on compound nucleus plus direct interaction reaction mechanisms. Spectroscopic factors for the lowest four levels in ^{13}C were determined. In addition, excitation curves of the reaction $^{13}C(p,p')^{13}C$ were measured at bombarding energies between 4.6 and 5.3 MeV. (auth)

1581 MICROSCOPIC ANALYSIS OF THE $^{6}Li(^{6}Li, ^{6}Li^{*}(3.56))^{6}Li^{*}$ (3.56) AND THE $^{6}Li(^{6}Li, ^{6}He)^{6}Be$ REACTIONS. Wharton, W.R. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. C 9: No. 1, 164-178 (Jan 1974).

A microscopic distorted-wave Born-approximation (DWBA) analysis of the $^{6}Li(^{6}Li, ^{6}Li^{*}(3.56))^{6}Li^{*}$ (3.56) and the $^{6}Li(^{6}Li, ^{6}He)^{6}Be$ reactions has been made and compared to microscopic studies of the (p, p') and (^{3}He, t) reactions. The tensor interaction and full exchange of the 1p shell nucleons has been included. Agreement between the calculation and the data is generally good with two exceptions, and this agreement suggests that the reactions are indeed quasielastic. Special emphasis is given toward explaining the differences between the measured $^{6}Li(^{6}Li, 6Li^{*}(3.56))^{6}Li^{*}$ (3.56) and $^{6}Li(^{6}Li, ^{6}He)^{6}Be$ cross sections. The cross sections should be equal according to charge independence because all final states are members of the same T = 1 isomultiplet. The theory correctly predicts the angular dependence of the difference in the two cross sections, but it does not predict the magnitude of the difference. The source of this disagreement may be attributed to differences in the wave functions of the final nuclei which are difficult to calculate. (auth)

1582 STUDY OF THE $^{6}Li(^{6}Li, ^{6}Li^{*}(3.56))\ ^{6}Li^{*}$ (3.56) AND THE $^{6}Li(^{6}Li, ^{6}He)\ ^{6}Be$ REACTIONS. Wharton, W.R.; Cramer, J.G.; Calarco, J.R.; Nair, K.G. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. C 9: No. 1, 156-163 (Jan 1974).

Angular distributions have been measured for the $^{6}Li(^{6}Li, ^{6}Li^{*}(3.56))^{6}Li^{*}$ (3.56) and the $^{6}Li(^{6}Li, ^{6}He)^{6}Be$ reactions at laboratory bombarding energies of 32 and 36 MeV, and excitation functions have been measured at 88° in the center of mass. All final-state nuclei are members of the same T = 1 isomultiplet and according to charge independence, the two reactions should have equal cross sections. Large differences in the cross sections of the two reactions are observed indicating that charge-dependent effects are important. For example at 32 MeV the ratio of the two cross sections, $^{6}Li(^{6}Li, ^{6}Li^{*})^{6}Li^{*}/^{6}Li(^{6}Li, ^{6}He)^{6}Be$, oscillates with angle, varying in magnitude from 0.17 to greater than 1.65. (auth)

1583 RADIATIVE ^{3}He CAPTURE IN ^{12}C and ^{16}O. Shay, H.D.; Peschel, R.E.; Long, J.M.; Bromley, D.A. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). Phys. Rev. C 9: No. 1, 76-101 (Jan 1974).

A comprehensive study has been completed on the ^{3}He radiative-capture reactions $^{9}Be(^{3}He, \gamma)^{12}C$, leading to the first four states of ^{12}C, and $^{13}C(^{3}He, \gamma)^{16}O$, leading to the first five states in ^{16}O. Excitation functions have been extended to excitations of 45 and 35 MeV, respectively, by bombarding natural ^{9}Be and isotopically enriched ^{13}C targets with ^{3}He from the Wright Nuclear Structure Laboratory MP tandem accelerator. Angular distributions have been taken at many key energies. These experiments utilized a large NaI(Tl) γ-radiation detector and plastic-scintillator cosmic-ray anticoincidence shield built as part of this program, and the IBM 360/44 on-line data acquisition system. Several resonances have been found. The experiment appears to confirm the role of 3p-3h configurations immediately above the giant resonances of ^{12}C and ^{16}O. Microscopic R-matrix calculations based on the Wang and Shakin 1p-1h and 3p-3h ^{16}O wave functions have been conducted. Detailed comparison of these calculations with our data and $^{15}N(p, \gamma_0)^{16}O$ data suggests that the source of much of the intermediate structure seen in the ^{16}O giant resonance may stem from the mixing of 1p-1h doorway configurations with 3p-3h configurations. (auth)

1584 ANGULAR CORRELATION STUDY OF THE PROTON DECAY OF ^{14}N STATES BELOW 11 MeV. Noé, J.W.; Balamuth, D.P.; Zurmühle, R.W. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 9: No. 1, 132-148 (Jan 1974).

Angular correlations of decay protons from 15 unbound ^{14}N states below $E_x = 11$ MeV were measured in the reaction $^{12}C(^{3}He, p)^{14}N(p)^{13}C_{g.s.}$. Incident ^{3}He energies of 12.0, 13.5 and 14.0 MeV were used in the various measurements. The decay protons (p) were detected in coincidence with reaction protons (p) emitted at 0° to the beam direction. The correlations were fitted to a theoretical expression containing adjustable parameters describing the ^{14}N substate populations and the angular momentum coupling in the $^{13}C+p$ system. Where two orbital angular momenta were allowed in the decay channel, generally only the lower allowed value was considered. Our results are compared with previous work and are shown to strengthen several existing J^{π} assignments. New assignments are: 10.06 MeV, $J^{\pi} = 3^{+}$ or $J \geq 4$; 10.81 MeV, $J^{\pi} = 5^{+}$. The f-/p-wave mixing in the decay of the 9.17-MeV 2^{+}, T=1 state is consistent with previous $^{13}C(p, \gamma)$ experiments; for the 10.43-MeV second 2^{+}, T=1 state, $\Gamma_{l=3} < (2.7 \times 10^{-3})\ \Gamma$. The measured magnetic substate parameters are compared with the predictions of a simple direct-interaction model of the (^{3}He, p) reaction. A recent weak-coupling model calculation of ^{14}N levels is reviewed in the light of the new results. (auth)

1585 ELECTROMAGNETIC DECAY OF THE 7.65-MeV STATE OF ^{12}C. Chamberlin, D.; Bodansky, D.; Jacobs, W.W.; Oberg, D.L. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. C 9: No. 1, 69-75 (Jan 1974).

A measurement has been made of the branching ratio, Γ_{rad}/Γ, for electromagnetic transitions from the 7.65-MeV state of ^{12}C. This ratio is of particular interest in that the rate of ^{12}C synthesis in stellar helium burning is proportional to Γ_{rad}. The 7.65-MeV state was excited by inelastic scattering of 24-MeV α particles on ^{12}C, and electromagnetic transitions were identified by detecting coincidences between the inelastic α particles and the associated ^{12}C ions remaining after γ-ray or electron-pair emission. It was found that $\Gamma_{rad}/\Gamma = (4.2 \pm 0.2) \times 10^{-4}$, which may be compared to the previous best value of $(2.9 \pm 0.3) \times 10^{-4}$. The new result, combined with available information on the width and branching ratio for electron-pair emission, leads to a radiative width $\Gamma_{rad} = \Gamma_{\gamma} + \Gamma_{ct} = (3.9 \pm 1.2)$ MeV. (auth)

1586 STUDY OF THE LOW-LYING STATES OF ^{9}Be. Chang, F.C. (Physics Department, St. John's University, Jamaica, New York 11432). Phys. Rev. C 9: No. 1, 1-3 (Jan 1974).

An extended version of the α-particle model which takes into account the internal motion of the nucleons is proposed for ^{9}Be. A two-center harmonic-oscillator potential is assumed for the nucleons. It is found that such a potential is not realistic enough to yield agreement with experiment. It is suggested that a two-center potential of the Woods-Saxon type may be a better choice. (auth)

1587 LIFETIME OF THE ^{16}O 4^{+}_{1} STATE AT 3.555-MeV EXCITATION. Coffin, J.P.; Gallmann, A.; Haas, F.; Wagner, P.; Olness, J.W. (Centre de Recherches Nucléaires et Université Louis Pasteur, Laboratoire de Physique Nucléaire et d'Instrumentation Nucléaire, 67037-Strasbourg-Cedex, France). Phys. Rev. C 9: No. 1, 38-42 (Jan 1974).

The recoil distance method was used to measure the lifetime of the $J^{\pi} = 4^{+}$ second excited state of ^{16}O at 3.555-MeV excitation, which was formed via the $^{16}O(t, p)^{18}O^{*}$ reaction at $E_t = 3.1$ MeV. The mean life is found to be $\tau = 46.2 \pm 3$ psec, which corresponds to an E2 strength for the 3.55 $(4^{+}) \rightarrow 1.98$ (2^{+}) transition of $|M(E2)|^2 = 0.64 \pm 0.05$ Weisskopf units. This result is in good agreement with

the predictions of recent theoretical calculations in the weak-coupling model, which identifies the lowest-lying 2^+ and 4^+ states as predominantly 2p-0h states based on ^{16}O. The predictions of this method for mirror states ^{18}O-^{18}Ne are discussed. Additional data were obtained coincidentally for states of ^{18}F formed via the competing $^{16}O(t, n)^{18}F^*$ reaction. The results, which are in good agreement with previous values, are: 0.937-MeV state, $\tau = 65.4 \pm 5.3$ psec and for the 1.081-MeV state, $\tau = 26.1 \pm 2.3$ psec. (auth)

1588 ISOSPIN-FORBIDDEN $^{12}C(d, \alpha_2)^{10}B$ REACTION. Jolivette, P.L. (Department of Physics University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. C 9: No. 1, 16-22 (Jan 1974).

A partial-wave analysis is presented for new data on the isospin-forbidden $^{12}C(d, \alpha_2)^{10}B$ reaction for $13.8 \leq E_d \leq 16$ MeV. Two levels with $J^\pi = 5^-$ are found at $E_x = 22.51$ and 23.36 MeV with widths of 610 and 500 KeV, respectively (uncertainties are $\simeq$ 100 keV in all cases). The prominent asymmetry in the region is due to interference between these levels and the tails of lower-energy levels. Consequently, no direct or semidirect reaction mechanism is necessary to explain the yield. The levels found appear to constitute an isospin-mixed pair with $\langle H_c \rangle > 40$ keV. The allowed $\alpha_{0,1,3}$ transitions were measured simultaneously. (auth)

1589 EVIDENCE FOR A NUCLEAR LEVEL IN ^{11}B AT 16.43 MeV. Annegarn, H.J.; Mingay, D.W.; Sellschop, J.P.F. (Nuclear Physics Research Unit, University of the Witwatersrand, Johannesburg, South Africa). Phys. Rev. C 9: No. 1, 419-421 (Jan 1974).

Evidence for a level at 16.43 MeV in ^{11}B is found in excitation functions measured for outgoing proton channels from the reaction ^9Be + d. Supporting evidence for this level is found in earlier works. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 1570, 1573, 1574, 1576, 1606, 1629, 1630, and 1706.

1590 DECAY OF ^{34}Ar: A MIRROR COMPARISON OF SUPER-ALLOWED β-DECAY. Hardy, J. C.; Schmeing, H.; Geiger, J. S.; Graham, R. L. (Chalk River Nuclear Labs., Ont.). Nucl. Phys.; A223: No. 1, 157-173(1974).

The decay of ^{34}Ar has been studied in experiments that employed a gas-transport system to reduce background activities. Through observation of the spectrum of β-delayed γ-rays, the half-life of ^{34}Ar was determined to be 844.5 ± 3.4 ms with $(94.44^{+0.30}_{-0.28})\%$ of the β-decays proceeding by the superallowed branch; four other decay branches were observed and their intensities measured. The ft value of 3046 ± 17 s for ^{34}Ar is compared with the best current value for ^{34}Cl to yield a mirror asymmetry of $\Delta = (-0.2 \pm 0.6)\%$. This result is now consistent with the calculated effects of charge-dependent mixing and lends confidence to those calculations. The final corrected $\mathcal{F}t$ values for ^{34}Cl and ^{34}Ar are in complete agreement with the other accurately known results for ^{14}O and ^{26m}Al, and between them these results yield a credible value for the vector coupling constant of nuclear β-decay. (auth)

1591 STRUCTURE OF THE NUCLEUS ^{29}P. Byrski, T.; Beck, F. A.; Engelstein, P.; Forterre, M.; Knipper, A. (Univ. Louis Pasteur, Strasbourg). Nucl. Phys.; A223: No. 1, 125-144(1974). (In French).

The $^{28}Si(p,\gamma)^{29}P$ reaction was used between E_p = 371 and 2880 keV to study the γ-ray decay of ten excited states of ^{29}P. Gamma-ray angular distributions were measured with Ge(Li) detectors and γ-γ angular correlations with a multicounter goniometer. Resonance strengths as well as γ-ray branching ratios have been measured precisely. Spin values of the 2.42, 3.45, 4.08, 4.95 and 5.29 MeV levels were found to be $\frac{3}{2}$, $(\frac{1}{2})$, $\frac{1}{2}$, $\frac{5}{2}$ and $\frac{1}{2}$, respectively. Mixing ratios of γ-rays were also measured. From Doppler-shift attenuation measurements the mean lives of the 1.38, 1.95, 2.42 and 4.08 MeV levels have been found as 240 ± 70, 450 ± 90, 25 ± 12 and 15 ± 4 fs, respectively. Additional measurements in the $^{28}Si(d,n\gamma)^{29}P$ reaction yield the lifetimes of the 1.38, 1.95, 2.42 and 3.11 MeV levels as 205 ± 25, 465 ± 60, 33 ± 11 and 33 ± 15 fs, respectively. The ^{29}P nuclear structure is discussed in the collective model and shell model framework. (auth)

1592 ENERGY DEPENDENCE OF THE CROSS SECTION AND POLARIZATION OF PROTONS DURING ELASTIC SCATTERING BY ^{27}Al. Gulamov, I. R.; Mikhaleva, T. N.; Romanovskii, E. A.; Chuprunov, D. L. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 130-132(Jan 1974). (In Russian).

Measurements were made of the energy dependence of the elastic scattering cross section and polarization of protons during their elastic scattering by ^{27}Al in the energy range from 6.2 to 6.7 MeV. The analysis of the energy dependence of the cross section and polarization confirmed the assumption expressed previously that the resonance character of the excitation function is connected with the excitation in the ^{27}Al compound nucleus of the isobaric analog state. (tr-auth)

1593 POLARIZATION STUDIES OF GROUND-STATE RADIATION FROM THE 2.21 AND 2.73 MeV LEVELS OF ^{27}Al. Gardner, P. R.; Baxter, A. M.; Bell, R. A. I.; Carlson, L. E.; Kean, D. C.; Ophel, T. R.; Spear, R. H. (Australian National Univ., Canberra). Aust. J. Phys.; 26: No. 6, 739-746(Dec 1973).

The E2/M1 mixing ratios of the ground-state γ-ray transitions from the 2.21- and 2.73-MeV levels of ^{27}Al were measured using a three-crystal Compton polarimeter in order to resolve discrepancies between previous experimental results for the 2.73-MeV transition. (auth)

1594 STUDY OF THE 2.8-KeV NEUTRON RESONANCE OF SODIUM AND AN ANALYSIS OF THE TOTAL NEUTRON CROSS SECTION UP TO 50 KeV. Seltzer, J.; Firk, F. W. K. (Yale Univ., New Haven). Nucl. Sci. Eng.; 53: No. 4, 415-419(Apr 1974).

The total neutron cross section of sodium was measured in the vicinity of the 2.8-keV resonance with the high-resolution time-of-flight spectrometer associated with the Yale University 70-MeV Electron Linear Accelerator. The spin of the resonance is unambiguously identified to be J = 1. A least-squares analysis of the cross section was carried out up to an energy of 50 keV by using a model that takes into account the effects of local and distant levels. The observed total cross section is well described throughout the entire range with a spin-independent interaction radius of 5.8-fm and with reasonable values of the R functions (distant level effects) for both spin states. The resonance energy, the neutron width, and the effective nuclear radii derived from the analysis are, respectively, $E_R = 2805 \pm 30$ eV, $\Gamma_{nR} = 376 \pm 15$ eV, $a_{J=1} = 5.3$ fm, and $a_{J=2}(E) = 5.7 + [2 \times 10^6/(E + 18500)^2]$ fm. (3 figures) (auth)

1595 CYCLIC ACTIVATION ANALYSIS AT A NEUTRON GENERATOR. Chultem, D. (Mongolian State Univ., Ulan Bator). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 723-724(1972). (In Russian).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1596 STUDIES ON THE MOMENTS OF INERTIA OF LIGHT NUCLEI. Part I. Calculations in the sd Shell Using Skyrme-Type Formulas. Ng, W. Y.; Trainor, L. E. H. (Univ. of Toronto). Can. J. Phys.; 52: No. 6, 541-553(15 Mar 1974).

The Hartree–Fock–Skyrme approach to calculations of the nuclear moment of inertia is generalized. It is shown that a different formula than the usual Skyrme formula can be expected to give better results. This result is illustrated by calculations on even–even nuclei in the sd shell. (auth)

1597 β DECAY OF ^{22}F. Davids, C.N. (Center for Nuclear Studies, University of Texas at Austin, Texas 78712); Goosman, D.R.; Alburger, D.E.; Gallmann, A.; Guillaume, G.; Wilkinson, D.H.; Lanford, W.A. Phys. Rev. C 9: No. 1, 216-226 (Jan 1974).

^{22}F was produced in the $^{18}O(^6Li,2p)^{22}F$ reaction by using 26-MeV $^6Li^{3+}$ ions. Following transfer of the target in a shuttle system, delayed γ and β rays were observed with Ge(Li) and NE102 plastic detectors. Several γ rays from ^{22}F decay were observed, decaying with a half-life of 4.23 ± 0.04 sec. γ–γ coincidence measurements have established that a 1900.0-keV transition terminates on a level in ^{22}Ne at 5523.4 keV, contrary to a previous study. The ground state of ^{22}F is of J = 4+ (with 3+ as a remote possibility) disagreeing with a previous assignment of 5+. Accurate excitation energies are presented for seven states in ^{22}Ne. Experimental results compare favorably with full (2s-1d) basis shell-model calculations of the A = 22 system. + (auth)

1598 STUDY OF 5.69- AND 5.78-MeV STATES IN ^{21}Ne THROUGH THE $^{20}Ne(d, p)^{21}Ne$ REACTION. Chambon, B.; Drain, D.; Elayi, G.; Gaillard, M.; Lambert, M. (Institut de Physique Nucléaire, Université Claude Bernard Lyon-I, Institut National de Physique Nucléaire et de Physique des Particules, 43, Bd du 11 novembre 1918, 69621 Villeurbanne, France); Beaumevieille, H.; Fasla, M. Phys. Rev. C 9: No. 1, 422-425 (Jan 1974).

We have investigated the states in ^{21}Ne at 5.69 and 5.78 MeV through the $^{20}Ne(d, p)$ reaction at 3.6 MeV. Distorted-wave Born-approximation (DWBA) fits have been performed for the angular distributions of these states; they indicate l=1 and 0 for the 5.69- and 5.78-MeV levels, respectively. Spectroscopic factors have been extracted. The correspondence between the states and their analog states in ^{21}Na is discussed. (auth)

1599 SPACE SYMMETRY IN LIGHT NUCLEI. I. APPLICATION TO THE 2s-1d SHELL. Parikh, J.C. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Ann. Phys. (N.Y.) 76: No. 1, 202-235 (Mar 1973).

The Wigner supermultiplet scheme is studied in the 2s–1d shell using the spectral distribution methods of French. Expressions for the average expectation value of H and H^2 over states belonging to a definite SU(4) symmetry are derived. Numerical results for these averages are given for the 2s–1d shell. These averages are then used to predict ground state energies and low energy spectra for nuclei in this shell, using Ratcliff's procedure; a comparison with shell model and observed spectra is made. Mixing intensities of SU(4) representations near the ground state are also evaluated. These provide us with a measure of symmetry breaking. It appears from our calculations that the symmetry is strongly mixed. Finally a preliminary application to the theory of level densities is made. (auth)

1600 ^{26}Mg(t, ^{3}He) REACTION AND A SPHERICAL-SHELL-MODEL DESCRIPTION OF ^{26}Na. Flynn, E.R. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Garrett, J.D. Phys. Rev. C 9: No. 1, 210-215 (Jan 1974).

The ^{26}Mg(t, ^{3}He) reaction at an incident energy of 23.5 MeV has been used to measure the ground-state mass and the energies of the excited states of ^{26}Na. The measured mass excess (−6.903 ± 0.020 MeV) is in agreement with that measured using the ^{26}Mg(^{7}Li, ^{7}Be) reaction and with the most recent β-decay end-point measurement. The spectrum of low-lying levels together with a recent assignment of 3^+ for the ground-state spin are not consistent with a rotational interpretation for ^{26}Na. These data, however, can be explained in terms of the spherical shell model. (auth)

1601 PROTON–γ ANGULAR CORRELATIONS IN THE REACTION ^{24}Mg(d, pγ)^{25}Mg. Vogler, F.; Berg, M.; Hofmann, A.; Wagner, H. (Physikalisches Institut III der Universität Erlangen-Nürnberg, Erlangen, Germany). Phys. Rev. C 9: No. 1, 242-251 (Jan 1974).

The reaction ^{24}Mg(d,pγ)^{25}Mg has been studied at a deuteron energy of 10 MeV up to an excitation energy in ^{25}Mg of 3.5 MeV. A multidetector arrangement consisting of eight silicon surface-barrier detectors has been used to measure the proton spectra. Particle-γ-coincidence measurements have been performed with a Ge(Li) detector in and perpendicular to the reaction plane. The angular distributions of the absolute double differential cross sections have been measured for particle angles between 30 and 150°. It turned out that the differential as well as the double differential cross section for transitions with an l transfer of 0 or 1 can be described well by the distorted-wave Born-approximation (DWBA) method. DWBA fails to describe the angular correlations of the l=2 transitions. The "j-forbidden" l=4 transitions leading to the $7/2^+$ state at 1.611 MeV and $9/2^+$ state at 3.399 MeV have been compared with Hauser-Feshbach predictions. While the differential cross section of the transition to the $7/2^+$ state is compatible with Hauser-Feshbach calculations, the double differential cross sections for both transitions cannot be described by Hauser-Feshbach theory. Potential ambiguities, arising from DWBA analyses of the differential cross sections could not be removed from the analyses of the double differential cross sections. (auth)

1602 FERMI BETA DECAY: THE MASSES OF ^{22}Mg, ^{26}Si, ^{30}S, AND ^{34}Ar. Hardy, J.C.; Schmeing, H. (Atomic Energy of Canada Limited, Physics Division, Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada KOJ-1JO); Benenson, W.; Crawley, G.M.; Kashy, E.; Nann, H. Phys. Rev. C 9: No. 1, 252-257 (Jan 1974).

The Q values for (p, t) reactions leading to ^{22}Mg, ^{26}Si, ^{30}S, and ^{34}Ar have been measured, yielding mass excesses for these nuclei of −399 ± 3 keV, −713 ± 3 keV, −14 062 ± 3 keV, and −18 379 ± 3 keV, respectively. The results for ^{22}Mg and ^{34}Ar are significantly different from average values quoted in the 1971 mass Tables. For all four nuclei, these results allow the ft values for their Fermi β-decay branches to be calculated with improved precision, and in the cases of A = 26 and A = 34 more exacting comparison of mirror Fermi decays become possible. The measured asymmetries now are Δ (26) = −1.2 ± 1.6% and Δ (34) = 0.2 ± 0.6%, thus removing any obvious disagreement with calculations of charge-dependent mixing. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 8, 1557, 1610, 1628, 1630, 1693, 1706, and 1707.

1603 BOUND STATES OF ODD–ODD NUCLEI. Vorob'ev, V. D. (All-Union Scientific-Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 101-104(Jan 1974). (In Russian).

The majority of the deviations of the energies of levels of odd–odd nuclei, following ^{50}Sc and ^{50}Nb, from the relations established in the shell model with two-particle forces are explained by the assumption of renormalization of the central part of the effective two-particle interaction in a multiparticle system. By means of one free parameter, agreement was obtained with the experimental data for each group of nuclei by use of simple shell-model states. (2 tables) (tr-auth)

1604 LEVELS IN ^{45}Sc FROM RADIATIVE PROTON CAPTURE IN ^{44}Ca. Schulte, R. L.; King, J. D.; Taylor, H. W. (Univ. of Toronto). Can. J. Phys.; 52: No. 2, 131-139(15 Jan 1974).

A total of 22 resonances were observed in the ^{44}Ca(p,γ)^{45}Sc reaction within the incident proton energy range of 600 to 930 keV. Gamma-ray singles spectra and γ-ray angular distribution data were accumulated for resonances at E_p = 856 and 906 keV. Both of these resonant states were found to have spin $^3/_2$. The measured angular distributions of primary γ rays from the resonant states were spin information on the intermediate bound states of ^{45}Sc with excitation energies above 2 MeV. A γ-ray decay scheme was derived from the γ-ray spectra. The data indicate new levels at 2151.0, 3525.2, 3548.5, 3584.0, and 3714.3 keV. (auth)

1605 CROSS SECTIONS AND SPECTRA FROM THE INELASTIC SCATTERING OF 14-MeV NEUTRONS FROM Si, S, Ca, Ti, V, Cr, Co, Nb, Ta, AND Au. Hantzsch, L.; Hermsdorf, D.; Heyer, J.; Moritz, H.; Pasieka, K.; Sassonoff, S.; Deeliger, D.; Seidel, K.; Zill, K. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 718-720(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1606 STUDY OF THE TOTAL EXCITATION CROSS SECTION OF Cr AND Si IN THE NEUTRON ENERGY REGION OF 2.9 TO 3.3 MeV. Pose, H.; Seidel, K.; Ung, T. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 721-723 (1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1607 MEASUREMENT OF THE MAGNETIC MOMENTS OF THE EXCITED STATES AT 1290 keV IN ^{41}K AND AT 760 keV IN ^{51}Cr. Kornienko, N. D.; Kul'chinskii, B. G.; Levon, A. I.; Nemets, O. F. (Inst. of Nuclear Research, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 156-164(Jan 1974). (In Russian).

The magnetic moments of the 1290-keV state of ^{41}K and of the 760-keV state of ^{51}Cr were measured in the U-120 cyclotron beam by using the differential angular distribution of the γ rays in the external magnetic field. The magnetic moments equaled +(4.53 ± 0.12) and −(0.86 ± 0.12), respectively. (3 figures, 2 tables) (tr-auth)

1608 ANGULAR-CORRELATION AND BRANCHING-RATIO STUDIES OF ^{41}Ca WITH THE ^{40}Ca(d,pγ)^{41}Ca REACTION. McIntyre, L.C. Jr. (Department of Physics, University of Arizona, Tucson, Arizona 85721). Phys. Rev. C 9: No. 1, 200-209 (Jan 1974).

Collinear-geometry angular-correlation and branching-ratio information is presented on 28 levels in ^{41}Ca up to approximately 4.5 MeV excitation. The ^{40}Ca(d,pγ)^{41}Ca reaction was used with an incident deuteron energy of 3 MeV. γ rays were detected with a Ge(Li) detector. (auth)

1609 STUDY OF THE (p,t) REACTION ON THE EVEN-A TITANIUM ISOTOPES. Baer, H.W.; Kraushaar, J.J.; Moss, C.E.; King, N.S.P.; Green, R.E.L.; Kunz, P.D.; Rost, E. (Nuclear Physics Laboratory, Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado, 80302). Ann. Phys. (N.Y.) 76: No. 2, 437-482 (Apr 1973).

The (p,t) reaction on the nuclei ^{50,48,46}Ti has been studied at bombarding energies of 27, 23, and 19 MeV. The angular distributions (5°–110° lab) of approximately 30 transitions at 27 MeV with L=0, 2, 3, 4 were examined for characteristic features which could be uniquely associated with the L transfer. Both the empirical systematics and the comparisons with distorted-wave Born approximation (DWBA) calculations were found to provide less reliable L-value determinations, other than for L=0, than is often assumed. The DWBA theory of the (p,t) reaction is discussed, and theoretical expressions employed in the calculations are given in an appendix. The DWBA calculations were extensively investigated for sensitivity to input parameters and assumed transfer configuration. It is shown that the relative phases of the form factor terms can affect angular distribution shapes at forward angles. A successful element of the theory was the description of the energy dependence in the differential cross sections of the ^{50}Ti(p,t)^{48}Ti (ground state) transitions between 27 and 19 MeV when a recently developed energy dependent mass-3 potential was employed. Magnitudes of the reaction differential cross sections were expressed in terms of a "single pair unit" defined relative to a local, zero-range, DWBA calculation assuming a single transfer configuration. In

comparing our strength values with those of a similar study at 51 MeV, we find differences up to a factor of four. Our measurements provide some new spin-parity information. Several new 0+ states as well as states with $2 \leq J \leq 6$ in ^{40,46,44}Ti are identified. Some rather striking disagreements with other studies were encountered. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 413, 1617, 1628–1630, 1636, and 1706.

1610 SCATTERING OF PROTONS WITH ENERGY ~6 MeV BY THE NUCLEI ^{58,60,62,64}Ni AND ^{59}Co. Gubin, V. B.; Kalacheva, Z. F.; Romanovskii, E. A.; Sirotinin, E. I.; Spasskaya, T. I.; Shishkin, K. S. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 133-139(Jan 1974). (In Russian).

In the energy range $5.8 \leq E_p \leq 6.4$ MeV the energy and angular dependences of the cross sections for elastic scattering of protons by ^{59}Co and ^{58,60,62,64}Ni were measured. The energy dependence of the cross section for proton inelastic scattering by ^{58,60}Ni with excitation of the first 2^+ level was also measured. The data on the elastic scattering were compared with the predictions of the optical model. (5 figures, 4 tables) (tr-auth)

1611 DECAY OF ^{87}Nb. A New Isotope ^{86}Nb. Votsilka, I.; Kratsik, B.; Liptak, Ya.; Novgorodov, A. F.; Toshev, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 57-62(Jan 1974). (In Russian).

The γ and $\gamma-\gamma$ coincidence spectra of ^{87}Nb were studied. Seventeen γ transitions were detected. A decay scheme for ^{87}Nb is proposed. A new isotope ^{86}Nb with a half-life $T_{\frac{1}{2}} = 1.4 \pm 0.2$ min was detected. (4 figures, 1 table) (tr-auth)

1612 DECAY OF ^{75}Se. Sutela, V. (Turku Univ., Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 407, 1-23(Jan 1974).

The gamma spectra of ^{75}Se were studied, employing a semiconductor and a scintillation detector. Coincidence spectra were measured with a Ge(Li)–Na(Tl) combination. The energies and intensities of 12 lines were measured: 66.20 keV (0.97), 96.77 keV (4.7), 121.18 keV (25.4), 135.98 keV (90.3), 198.55 keV (2.5), 264.52 keV (100), 279.44 keV (42.5), 304.00 keV (2.20), 401.27 keV (19.0), 419.15 keV (0.014), 573.00 keV (0.054) and 617.84 keV (0.0075). Gamma–gamma angular correlations were measured with a Ge(Li)–Na(Tl) combination. Correlation functions were calculated for four cascades: 121–280 keV, 136–265 keV, 136–66 keV, and 66–199 keV. From the angular correlation functions the spin of the levels, the multipole values and the mixing parameters of the transitions of ^{75}As were determined. The following values for the mixing parameters were obtained: δ(280 keV) = −0.453, δ(265 keV) = −0.173, and δ(66 keV) = 0.19. (auth)

1613 ANGULAR DISTRIBUTIONS IN PROTON–NUCLEUS COLLISIONS AT 67 AND 200 GeV. Babecki, J.; Czachowska, Z.; Furmanska, B.; Gierula, J.; Holynski, R.; Jurak, A.; Krzywdzinski, S.; Nowak, G.; Slezak, B.; Wolter, W. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol.; B5: No. 2, 315-320(1974).

Angular distributions of particles produced in collisions of protons with the nuclei of photographic emulsion are investigated in function of the excitation of the target nucleus. The data favor the models of elementary collisions in which particles are generated through an intermediate state. (auth)

1614 γ DECAY FROM THE ISOBARIC ANALOG RESONANCE OF ^{63}Ni$_{g.s.}$. Ramavataram, K.; Yang, C.S.; Mercier, G.F.; St-Pierre, C.; Sykes, D. (Laboratoire de Physique Nucleaire et Departement de Physique, Université Laval, Québec, Canada). Phys. Rev. C 9: No. 1, 237-241 (Jan 1974).

The decay widths for the M1 and E2 transitions in the γ decay of the isobaric analog resonance of the ^{63}Ni$_{g.s.}$ have been measured. The preferential excitation of a group of $1/2^-$ and $3/2^-$ states in these transitions with $\Delta T = 1$ can be directly related to the hindrance of the β decay of ^{63}Ni$_{g.s.}$. A detailed comparison with the predictions of the shell model shows the necessity of including excitations from the $1f_{7/2}$ shell in the calculation. (auth)

1615 Zn(^{3}He, d) REACTIONS AT 18 MeV. Zeidman, B.; Siemssen, R.H.; Morrison, G.C.; Lee, L.L. Jr. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 1, 409-412 (Jan 1974).

Differential cross sections and spectroscopic strengths have been measured for the (^{3}He, d) reaction on targets of ^{64,66,68,70}Zn at a ^{3}He energy of 18 MeV. For the three lighter isotopes general agreement is found with the results of the (d, n) experiment of Couch et.al. Results for the reaction ^{70}Zn(^{3}He, d)^{71}Ga suggest a significant break in the structure of the Ga isotopes at N = 40. It is suggested that this may be due to the n–p interaction between nucleons in the same subshell. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 409, 413, 1557, 1576, 1603, 1613, 1685, 1689, and 1706.

1616 (ITEF-22) STRUCTURE OF THE DIPOLE RESONANCE IN PHOTONUCLEAR REACTIONS. Ishkhanov, B. S.; Shevchenko, V. G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1973. 17p. INIS.

Aspects of the structure of the dipole resonance in the interaction of photons with light, intermediate, and heavy nuclei are studied. The results have been obtained at a betatron with E max = 35 MeV by using automatic change of the energy of the gamma beam. The results are compared with theoretical models. (12 figures) (auth)

1617 (n,2n) CROSS SECTIONS OF ^{85}Rb, ^{87}Rb, AND ^{144}Sm. Ghorai, S. K. (Alabama State Univ., Montgomery); Vos, R.; Cooper, J. R.; Alford, W. L. Nucl. Phys.; A223: No. 1, 118-124(1974).

The (n,2n) cross sections at neutron energies between 14.9 and 17.0 MeV have been measured for ^{85}Rb, ^{87}Rb and ^{144}Sm by the mixed-powder method and γ-ray detection by a Ge(Li) spectrometer. Using the ^{27}Al(n,α)^{24}Na reaction for monitoring, the measured cross sections were (in mb): ^{85}Rb(n,2n)$^{84(m+g)}$Rb, 1125 ± 141, 1177 ± 148 and 1235 ± 162 at 15.0 ± 0.4 MeV, 16.2 ± 0.7 MeV and 17.0 ± 0.9 MeV, respectively; ^{85}Rb(n,2n)^{84m}Rb, 662 ± 83, 688 ± 87 and 765 ± 99 at 15.0 ± 0.4 MeV, 16.2 ± 0.7 MeV and 17.0 ± 0.9 MeV, respectively; ^{87}Rb(n,2n)$^{86(m+g)}$Rb, 1336 ± 168 and 1301 ± 162 at 15.0 ± 0.4 MeV and 16.2 ± 0.7 MeV respectively; ^{144}Sm(n,2n)$^{143(m+g)}$Sm, 1202 ± 130, 1300 ± 141, 1516 ± 179 and 1514 ± 179 at 14.9 ± 0.3 MeV, 15.5 ± 0.3 MeV, 16.4 ± 0.5 MeV and 16.7 ± 0.2 MeV, respectively. The measured values are compared with the statistical model calculations of Pearlstein. (auth)

1618 NUCLEAR REACTIONS OF ^{118}Sn, ^{121}Sb, AND ^{127}I WITH ARGON IONS. Gauvin, H. (Institut de Physique Nucleaire, Orsay, France); LeBeyec, Y.; Porile, N. T. Nucl. Phys.; A223: No. 1, 103-117(1974).

Excitation functions have been measured for a number of (^{40}Ar, xn), (^{40}Ar,pxn), (^{40}Ar,2pxn), and (^{40}Ar,3pxn) reactions induced in ^{118}Sn, ^{121}Sb and ^{127}I over the lab. energy interval 150-280 MeV. Values of the total fusion cross section are obtained and J_{crit} is deduced. The value of J_{crit} increases with energy and becomes as large as 110-140$\hbar$, in reasonable agreement with the yrast limit deduced from the ellipsoidal liquid drop model. The competition between proton and neutron emission from the compound nucleus is examined and Γ_p/Γ_n is found to increase rapidly with the number of emitted nucleons, thereby imposing severe limits on the production of very neutron deficient nuclides via compound nuclear reactions. The effect of very high angular momentum on the excitation functions is examined. (auth)

1619 ENERGY LEVELS OF ^{124}Sn THROUGH THE (n,n'γ) REACTION. Kikuchi, S.; Sugiyama, Y. (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys.; A223: No. 1, 1-12(1974).

The energy levels of ^{124}Sn were studied by high resolution measurements of γ-rays from the (n,n'γ) reaction in the energy range 2.0-3.1 MeV. Fifteen levels at 1171, 1874, 2096, 2159, 2193, 2287, 2355, 2400, 2420, 2465, 2587, 2643, 2699, 2727 and 2835 keV were determined, and the spin-parity values were examined for twelve of them. The spin assignments were made by comparing the observed γ-ray angular distributions and level excitation functions with those calculated on the basis of statistical theory. (auth)

1620 INVESTIGATION OF THE INTERNAL CONVERSION ELECTRON SPECTRUM OF ^{148}Gd. Gavrilyuk, V. L.; Gromov, K. Ya.; Klyuchnikov, A. A.; Kupryashkin, V. T.; Latyshev, G. D.; Makovetskii, Yu. V.; Feoktistov, A. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 34-35(Jan 1974). (In Russian).

A study was made of individual parts (principally known K lines) of the ^{148}Gd spectrum. Data were obtained on the energies and relative intensities of the K lines. The ICC were determined and the multipole transitions were established. (1 table) (tr-auth)

1621 INVESTIGATION OF THE INTERNAL CONVERSION ELECTRON SPECTRUM OF ^{99}Tc. Gavrilyuk, V. L.; Klyuchnikov, A. A.; Kupryashkin, V. T.; Latyshev, G. D.; Maidanyuk, V. K.; Makovetskii, Yu. V.; Novgorodov, A. F.; Feoktistov, A. I. Izv.

Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 36-47(Jan 1974). (In Russian).

The decay of ^{96}Nb and ^{96}Tc to ^{96}Mo levels is discussed. New data on the internal conversion electron spectrum of ^{96}Tc are reported. In particular, the 1147.93-keV, 0^+ level is established. The relative intensities of the transitions are determined. A decay scheme, which is discussed on the basis of the shell model, is constructed. (5 figures, 3 tables) (tr-auth)

1622 NATURE OF THE LEVELS OF ^{136}Pr AND ^{138}Ce. Buttsev, V. S.; Vylov, Ts.; Kalinnikov, V. G.; Tikhonov, N. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 63-69(Jan 1974). (In Russian).

The γ and conversion electron spectra of ^{138}Nd, ^{138}Pr, and ^{138}Pr* were studied. The multipolarity of a series of γ transitions was established. $I^\pi = 0^+$ or 2^+, 0^+ or 2^+, 1^+, and 1^+ are assigned to the 194.2$^-$, 199.5$^-$, 326.9$^-$, and 541.1-keV levels of ^{138}Pr, respectively. A series of new states in ^{136}Ce was reported. (3 figures, 3 tables) (tr-auth)

1623 γ SPECTRA APPEARING IN (n,γ) REACTIONS ON ISOTOPES OF Ru. Barchuk, L. F.; Belykh, G. V.; Golyshkin, V. L; Ogorodnik, A. F.; Tuchinskii, M. M. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 70-74(Jan 1974). (In Russian).

The γ spectra of odd isotopes of Ru produced during thermal neutron capture by ^{96,98,100,102,104}Ru were measured. The measurements were made with a spectrometer with a Ge(Li) detector. The energies and intensities of the γ lines were determined in the energy range $3.5 < E_\gamma < 8.5$ MeV. (3 figures, 4 tables) (tr-auth)

1624 CALCULATION OF THE INTENSITY OF DOUBLE CONVERSION LINES IN CONVERSION ELECTRON SPECTRA. Eglais, M. O. (Latvian State Univ., Riga). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 82-83(Jan 1974). (In Russian).

The probability of the double conversion process was calculated for cases when one of the electrons is captured in the valence shell of the atom. The calculation was made for the E3 transition of ^{109}Ag at 87.8 keV. (tr-auth)

1625 STUDY OF THE DECAY OF ^{97}Ru WITH HIGH-PRECISION, HIGH-RESOLUTION GAMMA COINCIDENCE SPECTROSCOPY. Huber, B. Bochum, Ger.; Bochum Univ. (1972). 88p. (In German).

Thesis.

In a study of the decay of ^{97}Ru by means of a high-resolution $\gamma\gamma$-coincidence apparatus, a transition with 185 keV from the 970-keV level has been detected in the term scheme of the ^{97}Tc, and evidence is given for the ground-state transition of this level. An energy state at 580.26 keV is introduced; and the states at 574.2 and 946.5 keV, introduced by other authors, are ruled out. The parity assignment of the 995-keV level is questionable. An attempt is made to interpret the term scheme of the ^{97}Tc and that of the adjacent odd Tc isotopes in terms of a coupling of quasi particles with photons. (25 figures, 11 tables) (GE)

1626 DECAY OF ^{95}Tc*. Anton'eva, N. M.; Barkov, A. V.; Zolotavin, A. V.; Dmitriev, P. P.; Kamynov, Sh. V.; Katykhin, G. S.; Kondrat, E. T.; Krasnov, N. I.; Podkopaev, Yu. N.; Sergienko, V. A.; Fominykh, V. I. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 48-56(Jan 1974). (In Russian).

The γ, $\gamma-\gamma$ coincidence, internal conversion electron, and β^+ spectra of ^{95}Tc* appearing in equilibrium with ^{95}Tc are measured for the purpose of studying the level structure of ^{95}Mo. A supplementary and more precise decay scheme is given for ^{95}Tc*. Conclusions are made on the possible types of excitation of some levels of ^{95}Mo. (2 figures, 4 tables) (tr-auth)

1627 ANGULAR DISTRIBUTION OF PRE-COMPOUND PARTICLES IN THE REACTION ^{115}Sn(p,n)^{115}Sb. Narasimha Raju, M. L.; Rama Rao, J.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys.; 11: No. 8, 631(Aug 1973).

An analysis of the spectra of ^{115}Sn(p,n)^{115}Sb reaction on the basis of Griffin's formalism yielded the angular distributions of the pre-compound particles. From this distribution, it was concluded that these particles are more akin to direct reaction particles than to those of compound reaction and represent the intermediate structure of nuclear reactions. (auth)

1628 ISOSPIN DEPENDENCE OF THE REFORMULATED OPTICAL MODEL POTENTIAL. Sood, P. C.; Agrawal, D. C. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 11: No. 8, 571-576(Aug 1973).

It is shown that the presence of the isospin-dependent term in the potentials is not ruled out from analyses of the proton elastic scattering data using reformulated optical model. The results of the analyses are quite consistent with the strength of the isospin-dependent potential derived from usual optical model studies and from other determinations of this term. Comparison with the analyses of neutron scattering data provides positive evidence in favor of the presence of such a term and also reveals that the volume integral J_d of the spin-isospin-independent term in the nucleon–nucleon interaction (rather than the volume integral per particle, J_{RS}/A, of the real central part in the nucleon–nucleus interaction) is a fundamentally well defined quantity in the reformulated optical model. Further, J_{RS}/A and J_d are found to have an approximately linear variation with the incident proton energy. (auth)

1629 LOW ENERGY NEUTRONS FROM THE Pu–α–Be NEUTRON SOURCE. Peto, G.; Jozsa, I.; Csikai, J.; Shurie, G. M. (Kossuth Univ., Debrecen, Hungary). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 701-702(1972).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1630 INVESTIGATIONS ON NEUTRON INDUCED REACTIONS. Csikai, G. J. (Kossuth Univ., Debrecen, Hungary). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 709-710(1972).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1631 K-CAPTURE PROBABILITY IN THE DECAY OF ^{133}Ba FROM X-RAY–GAMMA-RAY SUMMING IN Ge(Li) DETECTORS. Das Mahapatra, B. K.; Mukherjee, P. (Saha Inst. of Nuclear Physics, Calcutta). J. Phys., A (London); 7: No. 3, 388-394 (11 Feb 1974).

A new technique has been developed in which a quantitative analysis of the sum-peaks observed with a high resolution Ge(Li) x-ray detector yields P_{K_i} the probability for K-electron capture to the two excited states $^1/_2{}^+$, 437.0 keV and $^3/_2{}^+$, 383.8 keV of ^{133}Cs in the decay of ^{133}Ba (10.4 yr). A total P_K has also been determined from the measurement of the gamma-ray and K x-ray intensities following the decay. (auth)

1632 CHARACTERISTICS OF THE ROTATIONAL BAND CONNECTED WITH THE ALIGNED STATES OF NUCLEI WITH EVEN MASS NUMBER. Peker, L. K. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 116-119(Jan 1974). (In Russian).

It is shown that the intervals between neighboring levels and, consequently, graphs of the relation $E - E_0 = f(I - I_0)$ for the rotational bands examined of the odd nuclei $^{125-133}$La and the neighboring even–even nuclei of $^{124-132}$Ba are actually very similar. The intervals between neighboring bands of ^{104}Pd, ^{100}Ru, ^{105}Pd, and ^{101}Ru are also very close. For band levels in these isotopes with one and two unpaired nucleons the relation $E - E_0 = f(I - I_0)$ is practically the same as for ground bands of even–even nuclei. (JSR)

1633 VALENCE COMPONENT IN THE THRESHOLD PHOTONEUTRON SPECTRUM OF ^{91}Zr. Toohey, R.E. (University of Cincinnati, Cincinnati, Ohio 45221); Jackson, H.E. Phys. Rev. C 9: No. 1, 346-359 (Jan 1974).

Ground-state radiation widths ($\Gamma_{\gamma 0}$) for 36 $p_{1/2}$ photoneutron resonances in ^{91}Zr have been measured from 5–225 keV above threshold at the Argonne National Laboratory threshold photoneutron facility. Reduced neutron widths ($\gamma_n{}^2$) for the same resonances were obtained at the Oak Ridge Electron Linear Accelerator facility from total-cross-section measurements on ^{90}Zr. A strong correlation ($\rho = +0.59$) is observed between the two sets of widths. Because of a lack of knowledge of the relative phase of the compound-nucleus and valence amplitudes in the individual resonances, the average valence component cannot be deduced from the correlation analysis. However, one can obtain a mean compound-nucleus contribution by studying those resonances where the valence amplitude is expected to be negligible. By using such a procedure, an average valence component is obtained which is in excellent agreement with the average valence strength calculated from the valence model. The s-wave neutron strength function is $S^0 = (6.2 \pm 1.2) \times 10^{-4}$ and the p-wave strength function is $S^1 = (3.2 \pm 0.8) \times 10^{-4}$. The reduced photon width for E1 transitions is k (E1) $= (3.2 \pm 0.6) \times 10^{-3}$, in agreement with the single-particle reduced width derived from the Weisskopf model. The neutron widths are observed to follow a Porter–Thomas distribution, while the photon widths appear to follow a χ^2 distribution with two degrees of freedom. (auth)

1634 COUPLED-CHANNEL-BORN-APPROXIMATION STUDY OF (p, t) REACTIONS LEADING TO TWO-PHONON STATES OF VIBRATIONAL NUCLEI. Udagawa, T. (Center for Nuclear Studies, University of Texas, Austin, Texas 78712). Phys. Rev. C 9: No. 1, 270-282 (Jan 1974).

A coupled-channel-Born-approximation (CCBA) study is made of (p, t) reactions leading to two-phonon states of vibrational nuclei. A

detailed numerical analysis is performed, particularly for the ^{116}Cd(p, t)^{114}Cd reaction with the incident energy E_p = 28 MeV. It is shown that many features observed in the reactions, which cannot be explained by distorted-wave Born approximation (DWBA), can successfully be accounted for by CCBA. It is also shown that three-step processes play an essential role in the successful explanation of the observed data, particularly the cross sections of the 0^+ and 4^+ two-phonon states. (auth)

1635 USE OF THE BLOCKING EFFECT TO MEASURE NUCLEAR REACTION TIMES. Karamyan, S.A.; Melikov, Y.V.; Tulinov, A.F. (Joint Institute for Nuclear Research, Dubna). Sov. J. Part. Nucl. 4: No. 2, 196-216 (Oct 1973).

Literature on the use of the blocking effect to measure nuclear reaction times is reviewed. The physical nature of the orientational effects which arise as charged particles move through a crystal is analyzed. There is a brief review of the theory of the blocking effect and of the basic principles of measuring the nuclear lifetimes in the range $\tau < 10^{-15}$ s. The various types of experiments which have been carried out and the various methods which have been used to extract lifetimes from the experimental data are discussed. There is a summary of the results found in measurements of lifetimes of compound nuclei in inelastic scattering of protons, in (p, α) reactions, and in the fission of heavy nuclei by neutrons, protons, and heavy ions. The experimental results are compared with results calculated on the basis of the statistical model of the compound nucleus. (auth)

1636 P-WAVE NEUTRON STRENGTH-FUNCTION MEASUREMENTS AND THE LOW-ENERGY OPTICAL POTENTIAL. Camarda, H.S. (National Bureau of Standards, Washington, D.C. 20234). Phys. Rev. C 9: No. 1, 28-37 (Jan 1974).

Using the National Bureau of Standards electron linac and underground time-of-flight facility, precise average neutron-transmission measurements have been made in the energy range 1 keV $\leq E \leq$ 600 keV on the elements As, Br, Nb, Rh, Ag, In, Sb, I, La, Ho, Au, and Th. The samples were "thick" in that the s-wave self-protection had to be accounted for at low energies. However, the samples were still sufficiently thin that any errors introduced by neglecting p-wave self-protection were negligible. The average R-matrix theory was employed in the analysis and the $l = 0$ scattering length R' and the p-wave strength function S_1 were extracted from the data. The behavior of S_1 vs mass number A in the region of the 3P maximum was found to vary smoothly with no evidence of any splitting of the resonance. Using Moldauer's optical potential, which fits the $l = 0$ data well, the behavior of S_1 vs A was calculated. The predicted behavior was found to differ significantly from experiment. In particular, experiment indicates S_1 peaks at a lower mass number and that the maximum is stronger than indicated by the calculations. When the constants of the potential were changed in order to reproduce the observed behavior of S_1, a significant discrepancy with the $l = 0$ data resulted. The results presented here imply an orbital angular momentum dependence of the low-energy optical potential. (auth)

1637 MULTIPOLE MIXING RATIOS OF TRANSITIONS IN ^{99}Tc. Gardulski, P.L.; Wiedenbeck, M.L. (Department of Physics, The University of Michigan, Ann Arbor, Michigan 48104). Phys. Rev. C 9: No. 1, 262-265 (Jan 1974).

A Ge(Li) -Ge(Li) directional-correlation system has been utilized to measure the (740-40-141), (740-181), and the previously unreported (740-40) and (40-141) correlations. The multipole mixing ratios obtained were δ (740) = 3.58 + 0.20, δ (40) = - 0.008 + 0.008, δ (141) = -0.118 ± 0.006, and δ (181) = 0.002 ± 0.007. The first three mixing ratios are E2/M1 and the last one is M3/E2. In addition the spin assignment of 3/2 for the 921-keV level has been confirmed. (auth)

1638 DECAYS OF MASS-SEPARATED ^{138}Xe AND ^{138}Cs. Carlson, G.H.; Talbert, W.L. Jr.; McConnell, J.R. (Ames Laboratory, USAEC and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. C 9: No. 1, 283-298 (Jan 1974).

The β and subsequent γ decays of ^{138}Xe and ^{138}Cs were investigated using the on-line isotope separator system TRISTAN at the Ames Laboratory research reactor. Ge(Li) γ-ray singles and Ge(Li) -Ge(Li) γ-γ coincidence measurements were used to construct level schemes for ^{138}Cs and ^{138}Ba. For the decay of ^{138}Xe, 94 of 99 observed γ-ray transitions have been placed in a level scheme for ^{138}Cs with 27 excited states. For the decay of ^{138}Cs, 82 of 86 observed γ rays are placed in a level scheme for ^{138}Ba with 35 excited states. Ge(Li) -plastic coincidence measurements gave Q values of 2.83 ± 0.08 MeV and 5.29 ± 0.07 MeV for ^{138}Xe and ^{138}Cs, respectively. Spin and parity assignments have been deduced using γ-ray transition rates, β-decay logft values, and other information existing in the literature. Interpretation of some of the energy levels is made from a shell-model viewpoint. (auth)

1639 LEVELS OF ^{91}Rb AND ^{91}Sr FED IN THE DECAYS OF ^{91}Kr AND ^{91}Rb. Achterberg, E.; Iglesias, F.C.; Jech, A.E.; Moragues, J.A.; Otero, D.; Pérez, M.L.; Proto, A.N.; Rossi, J.J.; Scheuer, W. (Departamento de Física Nuclear, Comisión Nacional de Energía Atómica, Buenos Aires, Argentina). Phys. Rev. C 9: No. 1, 299-309 (Jan 1974).

Level schemes for ^{91}Rb and ^{91}Sr are proposed based on the study of the β decay of ^{91}Kr and ^{91}Rb, respectively. The samples were obtained using on-line mass-separation techniques applied to ^{235}U fission products. γ-, β-, and x-ray singles spectra, as well as (γ, γ) and (β, γ) coincidence spectra, were taken with Ge(Li) and Si(Li) detectors. Internal-conversion coefficients were determined for several transitions and the half-lives for the first two levels in ^{91}Rb and ^{91}Sr were measured. In view of the observed parity change between low-lying excited states and the ground state in ^{91}Rb the possibility of deformations to explain this level structure is discussed. (auth)

1640 RADIOACTIVE DECAY OF 2.2-h ^{127}Sn TO LEVELS OF ^{127}Sb. Apt, K.E. (Department of Chemistry, University of Maryland, College Park, Maryland 20742); Walters, W.B. Phys. Rev. C 9: No. 1, 310-325 (Jan 1974).

High-resolution Ge(Li) detectors have been used to observe γ-ray singles and coincidence spectra of 2.2-h ^{127}Sn ($11/2^-$ ground state). Sources of mixed tin isotopes were produced by thermal-neutron fission of enriched ^{235}U and were chemically separated by solvent extraction and sulfide precipitation. A total of 162 γ rays are attributed to the decay of ^{127}Sn^g, and 154 of these transitions have been placed in a ^{127}Sb level scheme involving 50 excited states. The β feeding from $11/2^-$ ^{127}Sn^g to the $7/2^+$ ^{127}Sb ground state was determined to be (22 ± 8) % (logft = 8.0). Spin and parity assignments for ^{127}Sb levels have been made in many instances. An 11 ± 1-μsec $15/2^-$ isomeric level in ^{127}Sb at 1920 keV has been identified. The level structure of ^{127}Sb is interpreted in terms of the shell model and core-excitation considerations. (auth)

1641 LINEAR-POLARIZATION MEASUREMENTS OF THE REACTION γ RAYS FROM ^{96}Zr(^{18}O, 4nγ)^{110}Cd. Lumpkin, A.H.; Sunyar, A.W. (Brookhaven National Laboratory, Upton, New York 11973); Hardy, K.A.; Lee, Y.K. Phys. Rev. C 9: No. 1, 258-261 (Jan 1974).

The strong linear polarizations of the deexcitation γ rays from the ^{96}Zr(^{18}O, 4nγ)^{110}Cd reaction at 60 MeV were measured using a Ge(Li) two-crystal Compton polarimeter. Previous experiments with this reaction resulted in the identification of a side band feeding into the known 4^+ and 6^+ states via two dipolar γ rays from states with spins 5 and 7 and with energies of 996 and 399 keV, respectively. These two dipole transitions were found to be E1. Several other known quadrupole transitions were found to be E2. Thus we assign odd parity to the levels at 2538 keV (5^-), 2878 keV (7^-), and 3344 keV (9^-). The feasibility of such measurements with this polarimeter is discussed. (auth)

1642 WEAK GAMMA TRANSITIONS IN 129-DAY ^{123}Sn^g DECAY. Raman, S.; Auble, R.L.; Dyer, F.F. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 9: No. 1, 426-427 (Jan 1974).

We have observed 12 γ rays in ^{123}Sb from the decays of 129-day ^{123}Sn^g and 40-min ^{123}Sn^m. These γ rays have been incorporated into a level scheme of ^{123}Sb with eight excited states. Discrepancies between a previous decay scheme and Sb(n, nγ) studies have been resolved. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 1576, 1628, 1630, 1676, 1684, 1685, 1688, and 1716.

1643 (JINR-P6-7760) NEW ISOTOPE ^{161}Yb($T_{1/2}$ = 4.2 min). Adam, J.; Beyer, G.; Honusek, M.; Gromov, K. Ya.; Siebert, H. U.; Kalinnikov, V. G.; Latuszynski, A.; Strusny, H.; Jachim, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 12p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

A new isotope ^{161}Yb($T_{1/2}$ = 4.2 min) was identified. Energies and intensities of gamma rays from the decay of this isotope were measured: $K_{\alpha 1}$ (100), 78.17 keV (49), 140.2 keV (3.3), 188.2 keV (4.5), 599.8 keV (39), 631.3 keV (21). (3 figures, 1 table) (auth)

1644 G-FACTOR OF THE 91.5-keV STATE IN ^{151}Sm. Drost, H.; Von Lojewski, H.; Palow, K.; Wallenstein, R.; Weyer, G. (Freie Univ., Berlin). Nucl. Phys.; A223: No. 1, 195-206(1974).

The g-factor of the 91.5 keV state in ^{151}Sm has been measured by the TDPAC method using $\gamma\gamma$ cascades following the β-decay of 28 h ^{151}Pm. The result is g = -0.21 ± 0.01. The anisotropy of the angular correlation for the 232.2-25.7 keV cascade is measured to be A = +0.058 ± 0.006. From this an M1/E2 mixing ratio of δ^2 = 0.008 ± 0.002 for the 232.3 keV transition is concluded. No attenuation of the anisotropy of the angular correlation is observed for aqueous solution sources of SmCl in excess

of hydrochloric acid. Spin and parity assignments for excited states in ^{151}Sm are presented. (auth)

1645 ENERGY OF TRANSITIONS BETWEEN EXCITED STATES OF THE NUCLEUS ^{172}Yb AT 1173 keV (3^+3) AND 78 keV ($2^+_\beta 0$). Balalaev, V. A.; Medvedev, A. L.; Ter-Nersesyants, V. E.; Uchevatkin, I. F.; Shestopalova, S. A. (All-Union Scientific-Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 25-28(Jan 1974). (In Russian).

The energy of the K 1093 electrons of ^{172}Lu was determined from the K and L_1 1063 lines of ^{207}Bi. The result obtained (E_γ = 1093.45 ± 0.05 keV) agrees almost completely with the result reported previously and calculated with the current value of the reference line used (1093.46 ± 0.12 keV). There is disagreement with the results of Bearden and Burr (1093.64 ± 0.02 keV). (2 figures, 1 table) (tr-auth)

1646 LEVEL STRUCTURE OF ^{184}W FROM THE ^{183}W(n,γ) REACTION. Greenwood, R. C.; Reich, C. W. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nucl. Phys.; A223: No. 1, 66-102(1974).

The level structure of ^{184}W has been studied from the prompt γ-rays emitted following the capture of both thermal and 2 keV neutrons by ^{183}W. Energies and intensities were measured for both the primary and the secondary (low-energy) prompt γ-rays. From these data, a level scheme is proposed for ^{184}W in which all the $I^\pi = 0^+$, 1^+ and 2^+ states below ≈ 2.0 MeV are observed. Where possible, rotational-band assignments have been made to these and other levels. Additional evidence is presented which confirms the 1130 keV state as being the band head of a $K^\pi = 2^-$ octupole vibrational band. Admixed $K^\pi = 0^+$ and 2^+ bands are established at 1322 and 1386 keV, respectively, with the $I^\pi = 2^+$ states (at 1431 and 1386 keV) having a mutual admixture of ≈ 12%. In the energy region above 1.5 MeV, the following bands and band-head energies are identified: $K^\pi = 1^+$, 1613 keV; $K^\pi = 0^+$, 1614 keV; $K^\pi = 1^+$, 1713 keV; $K^\pi = 2^+$, 1877 keV. The neutrino binding energy in ^{184}W has been determined to be 7411.1 ± 0.6 keV. The band structure of the 1613 keV (1^+) and 1614 keV (0^+) bands is observed to be strongly distorted, the observed A (≡$\hbar^2/2I$) values being ≈ 3.6 keV and ≈ 32 keV, respectively. This strong distortion is shown to be explainable in terms of Coriolis coupling of reasonable strength between the two bands. A similar explanation is shown to account for the somewhat less anomalous A-values (22.8 keV and 14.0 keV, respectively) of the 2^+ band at 1386 keV and the 3^+ band at 1425 keV. The results of a phenomenological five-band-mixing analysis involving the $K^\pi = 0^+$ and 2^+ bands below ≈ 1.5 MeV are presented and discussed. These calculations indicate, among other things, that the direct E2 matrix element connecting the 1322 keV, $K^\pi = 0^+$ band and the ground-state band is quite small, possibly zero. They also indicate that a nonzero E2 matrix element exists between this excited $K^\pi = 0^+$ band and the γ-vibrational band and that the magnitude of this element is comparable with that between the γ-vibrational and ground-state bands. Arguments favoring and apparently refuting the interpretation of the 1322 keV, 0^+ band as a "two-phonon γ-vibration" are presented. (auth)

1647 LEVEL STRUCTURE OF ^{184}W FROM THE DECAY OF ^{184g}Re AND ^{184m}Re. McMillan, D. J.; Greenwood, R. C.; Reich, C. W.; Helmer, R. G. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nucl. Phys.; A223: No. 1, 29-65(1974).

The level scheme of ^{184}W has been studied from the decay of 38d ^{184g}Re and 165d ^{184m}Re. Gamma-ray energy and intensity measurements were made using Ge(Li) and Si(Li) detectors; and conversion-electron measurements were made using an iron-free π√2 double-focusing spectrometer. From these data and extensive γ-γ coincidence measurements decay schemes for both ^{184}Re activities have been proposed which incorporate all 42 of the observed γ-ray transitions. Unique spin and parity assignments have been made for all the energy levels observed. Detailed intensity-balance considerations for each energy level have led to improved electron-capture branching ratios and log ft values. In addition to the previously known features of the ^{184}Re decay schemes, it has been established that levels at 1424 and 1431 keV in ^{184}W are weakly populated and that their I^π assignments are 3^+ and 2^+, respectively. Also, the $4^+ \rightarrow 2^+$ transition within the γ-vibrational band has been observed, which enables an estimate of the relative magnitudes of the intrinsic quadrupole moments of γ-vibrational and ground-state bands to be made. Within the experimental uncertainties involved (≈ 10%), these two moments are equal. A one-parameter analysis of the E2 transition probabilities between these two bands gives z_γ = +0.0408 ± 0.0041. Absolute transition probabilities are obtained and discussed for the γ-rays de-exciting the 3^- state at 1221 keV and the 5^- isomeric state at 1284 keV. Evidence for mixing of $K^\pi = 2^-$ and 3^- excitations in the 5^- isomeric state is presented; and a formalism for treating such admixtures, of both collective and two-quasiparticle character, is developed and applied. A close similarity of the M4 γ-decay of ^{184m}Re to that of the 10^- isomeric state in ^{182}Ta is noted. (auth)

1648 γ SPECTRUM APPEARING IN THE REACTION ^{187}Os(n,γ)^{188}Os. Barchuk, I. F.; Belykh, G. V.; Golyshkin, V. I.; Ogorodnik, A. F.; Tuchinskii, M. M.; Kalinin, S. K.; Latyshev, G. D. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 75-77(Jan 1974). (In Russian).

The γ spectrum appearing in the reaction ^{187}Os(n,γ)^{188}Os with thermal neutrons was measured with a spectrometer with Ge(Li) detectors. In the energy range $4.5 \leq E_\gamma \leq 8.0$ MeV, 35 γ lines connected with ^{188}Os transitions were detected. The binding energy of the last neutron was found to equal 7.9887 ± 0.0012 MeV. A transition scheme was proposed for ^{188}Os. (tr-auth)

1649 QUANTUM MECHANICS OF THE TWO MASS-POINT MODEL FOR THE ROTATIONAL SPECTRA OF DEFORMED EVEN-EVEN NUCLEI. Prakash, V. R.; Bahal, B. M.; Deshpande, V. K. (Indian Inst. of Tech., Kanpur). Can. J. Phys.; 51: No. 23, 2474-2487(1 Dec 1973).

The representation of a deformed nucleus by a two mass-point system is treated quantum mechanically to obtain absolute values of energies of the ground state rotational band and the first excited 0^+ vibrational state of even-even nuclei in the rare-earth region. Calculations are made using both harmonic and anharmonic restoring potentials. Although the model is not applicable to spherical nuclei, it is found that for the deformed nuclei in the rare-earth region it correlates the quadrupole moment and the moment of inertia data more satisfactorily than the rigid-body and hydrodynamic models. The values of energies, quadrupole moments, and the ratio $B(E2; 4^+ \rightarrow 2^+)/B(E2; 2^+ \rightarrow 0^+)$, predicted on the basis of the model, are in agreement with the corresponding experimental values for the nuclei around the middle of the region $150 \leq A \leq 190$. The variation of the stiffness of the potential with neutron and proton numbers is studied. (auth)

1650 SINGLE-PARTICLE ENERGIES AND WAVE FUNCTIONS OF THE WOODS—SAXON POTENTIAL AND NONROTATIONAL STATES OF ODD NUCLEI IN THE RANGE $150 < A < 190$. Gareev, F.A.; Ivanova, S.P.; Solov'ev, V.G.; Fedotov, S.I. (Joint Institute for Nuclear Research, Dubna). Sov. J. Part. Nucl. 4: No. 2, 148-195 (Oct 1973).

Single-particle energies and wave functions for the Woods-Saxon potential are given for deformed nuclei in the range $150 < A < 190$. The energies and wave functions for the nonrotational states of odd nuclei are calculated taking account of the quasiparticle-phonon interaction. The effect of $\Delta N = \pm 2$ mixing is taken into account. A study is made of how the difference between the equilibrium nuclear deformation in the excited state and that in the ground state affects the state energy and structure. A good description is found for the energies of the low-lying nonrotational states in this mass range. The calculated single-particle energies and wave functions for the Woods-Saxon potential can be used to calculate various characteristics of nuclei in this range. (auth)

1651 STUDY OF ^{166}Er BY MEANS OF THE (^{3}He, d) AND (α, t) REACTIONS. Katori, K.; Medsker, L.R.; Yntema, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 9: No. 1, 360-365 (Jan 1974).

Two-proton quasiparticle states in ^{166}Er have been studied with (^{3}He, d) and (α, t) reactions on ^{165}Ho. Rotational bands built upon quasiparticle states formed by the [532↑] proton state coupled with the [411↓], [404↓], and [541↓] proton states were identified. For each rotational band, the cross sections have a characteristic pattern which has been used to identify the band. Assignments were checked by comparing the ratios of (^{3}He, d) and (α, t) cross sections for each level. (auth)

1652 INTERNAL-CONVERSION STUDIES IN ^{177}Hf FROM THE DECAY OF ^{177}Lu. Agnihotry, A.P.; Gopinathan, K.P.; Jain, H.C. (Tata Institute of Fundamental Research, Bombay 400005, India). Phys. Rev. C 9: No. 1, 336-345 (Jan 1974).

The K-shell and L-subshell internal-conversion coefficients of the retarded transitions in ^{177}Hf populated in the decay of the 6.8-day ^{177}Lu have been measured using a high-resolution double-focusing electron spectrometer and a 20-cm^3 Ge(Li) detector. The K conversion coefficients of the 71.6- and 113-keV transitions have been determined by γ-γ and γ-x-ray coincidence measurements using a 1-cm^3 Ge(Li) detector having a thin window and a scintillation detector. The γ-γ, γ-e^K, and e^K-γ angular correlations of the 208.3-113-keV cascade have been measured using a single gap electron spectrometer, NaI(Tl) γ-ray spectrometers, and a Ge(Li) detector. The particle parameters for the K-conversion electrons of the transitions have been evaluated to be: $b^K_2(208.3) = -1.54 \pm 0.06$ and $b^K_2(113) = -0.20 \pm 0.02$. The 208.3-113-keV γ-γ angular correlation as measured using a $LuCl_3$ source in solution gave $W(\theta) = 1-(0.192 \pm 0.007)P_2(\cos\theta)$. The quadrupole admixtures and the penetration parameters of the transitions were evaluated by least-squares analysis of the conversion coefficients and particle

parameters. The best solutions are Q= (3.1±1.6) %, λ_1=−19.2±1.2, λ_2=250 ±240 for the 321.3-keV transition; Q<0.2%, λ_1=−0.8±0.9, λ_3 =0 for the 208.3-keV transition; Q= (0.03±0.02) %, λ_1=1.3±0.8 for the 71.6-keV transition; Q= (94.1±0.7) %, λ=5.6±8.4 for the 113-keV transition, and Q= (95±5) % for the 136.7-keV transition. From these values and the known lifetimes of the levels the γ-ray matrix elements and the penetration matrix elements have been calculated and compared with theoretical estimates based on Nilsson's model. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 1013, 1616, 1628–1630, 1636, 1678, 1685, and 1693.

1653 (JU-RR-73-15) E2/M1 MIXING OF THE TRANSITIONS FROM THE $K^\pi = 2^+$ BANDS IN ^{190,192}Os AND ^{192}Pt. Kaneko, K. (Jyvaeskylae Univ. (Finland). Dept. of Physics). Nov 1973. 27p. Dep. NTIS (U. S. Sales Only) $4.50.

Directional correlation method was used to determine multipole mixing ratios of several γ-transitions in ^{190,192}Os and ^{192}Pt. A new level at 1406.4 keV has been established in ^{192}Pt. The experimental E2/M1 mixing ratios of the transitions from the γ-bands have been compared with theoretical predictions of the Greiner model also including the rotation–vibration interaction, the Kumar–Baranger model and the Zackrevsky model. (auth)

1654 E2/M1 MIXING OF THE TRANSITIONS FROM THE $K^\pi = 2^+$ BANDS IN ^{190,192}Os AND ^{192}Pt. Helppi, H.; Pakkanen, A.; Hattula, J. (Univ. of Jyvaeskylae, Finland). Nucl. Phys.; A223: No. 1, 13-28(1974).

The directional correlation method was used to determine multipole mixing ratios of several γ-transitions in ^{190,192}Os and ^{192}Pt. A new level at 1406.4 keV has been established in ^{192}Pt. The experimental E2/M1 mixing ratios of the transitions from the γ-bands have been compared with theoretical predictions of the Greiner model also including the rotation-vibration interaction, the Kumar-Baranger model and the Zackrevsky model. (auth)

1655 ALPHA PARTICLES FROM ^{197}Au IRRADIATED BY 500-MeV BREMSSTRAHLUNG. Adler, J. O.; Andersson, G.; Gustafsson, H. A. (Lund Inst. of Tech., Sweden). Nucl. Phys.; A223: No. 1, 145-156(1974).

The energy and angular distributions of α-particles in the reaction ^{197}Au(γ, α) have been measured at nine different angles for bremsstrahlung with peak energy 500 MeV. The measurements were made using a telescope consisting of three Si surface-barrier detectors. The experimental results are compared with cascade-evaporation calculations and the angular distribution indicates the presence of directly emitted α-particles in competition with evaporated ones. (auth)

1656 MOESSBAUER EFFECT IN ^{195}Pt. Rueegg, W. (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 46: 735-769(1974). (In German).

Using a ferromagnetic $Fe_{0.9}Pt_{0.1}$ alloy as absorber the magnetic hyperfine interaction of the 99 keV and the 130 keV state of ^{195}Pt was investigated. From the 99 keV Mössbauer spectrum an internal field of $H_i = -1.34 \pm 0.09$ MG and an isomer shift of IS = −1.74 ± 0.08 mm/s were determined. Using the 130 keV transition the magnetic moment of the 130 keV state, $\mu_{130} = 0.90 \pm 0.08$ nm was measured. From the isomer shifts of the two transitions the ratio of the changes in the mean square charge radius of the two excited states $\Delta\langle r^2\rangle_{130}/\Delta\langle r^2\rangle_{99} = 1.3 \pm 0.2$ was obtained. It is shown that a modified Daniel–Friedel model is able to explain the variation of the internal fields in the neighborhood of platinum. From the Mössbauer measurements on PtO_2, $PtCl_4$, $PtCl_2$ and PtI_2 isomer shifts, f-factors, and line widths were deduced. The Mössbauer spectra of the one-dimensional conductor $K_2Pt(CN)_4Br_{0.3} \cdot 3(H_2O)$ and of $K_2Pt(CN)_4 \cdot 3(H_2O)$ and $K_2Pt(CN)_4Br$ were measured. From the isomer shifts and from the symmetry of the Mössbauer spectra it was concluded that in $K_2Pt(CN)_4Br_{0.3} \cdot 3(H_2O)$ charge is not localized on an atomic scale. From the line widths of these spectra the half-life of the 99 keV level, $\tau_{\frac{1}{2}} = 163 \pm 2$ ps was determined. (auth)

1657 RADIUS OF THE NEUTRON DISTRIBUTION IN ^{208}Pb FROM (p, n) QUASIELASTIC SCATTERING. Schery, S.D.; Lind, D.A.; Zafiratos, C.D. (Nuclear Physics Laboratory, Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80302). Phys. Rev. C 9: No. 1, 416-418 (Jan 1974).

A microscopic isospin interpretation of the (p, n) reaction is used to determine the ratio of the rms radii of the neutron and proton distributions in ^{208}Pb from (p, n) scattering data at 25.8 MeV. The result for the ratio is $\langle r_n^2\rangle^{1/2}/\langle r_p^2\rangle^{1/2} = 1.07 \pm 0.03$. (auth)

1658 CONCERNING THE QUESTION OF NONRESONANT NEUTRON CAPTURE IN ^{207}Pb. Phillips, T.W.; Bowman, C.D.; Berman, B.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Rev. C 9: No. 1, 407-408 (Jan 1974).

The presence of the asymmetry seen in the 40.8-keV resonance in the ^{208}Pb(γ, n_0) cross section cannot be explained by either the existence of a second nearby resonance or the ^{207}Pb contaminant in the sample. (auth)

1659 6^+ AND 11^- STATES EXCITED BY THE (p, t) REACTION ON LEAD ISOTOPES. Orihara, H.; Ishizaki, Y.; Trentelman, G.F. (Institute for Nuclear Study, University of Tokyo, Tanashi, Tokyo, Japan); Kanazawa, M.; Abe, K.; Yamaguchi, H. Phys. Rev. C 9: No. 1, 266-269 (Jan 1974).

Strong triton peaks in the (p, t) spectra on the lead isotopes with E_p = 51.9 MeV were observed. Assignments of 6^+ (or an L = 6 transfer) were made from comparisons with distorted-wave Born-approximation predictions assuming a $(2f_{5/2}, 2f_{7/2})^{-1}$ two-hole state as their main configuration. Further, a pronounced peak was found near E_x = 5 MeV at relatively large scattering angles in both the ^{206}Pb(p, t)^{204}Pb and ^{208}Pb(p, t)^{206}Pb reactions. Assignment of an L = 11 transfer which corresponds to an $[(h_{9/2}, i_{13/2})^{-1}]_{11^-}$ two-hole state in the residual nucleus was made for such states. (auth)

1660 EFFECT OF ATOMIC CHARGE STATE ON NUCLEAR LIFETIMES: ^{197}Au. Ulrickson, M.; Hensler, R.; Gordon, D.; Benczer-Koller, N. (Department of Physics, Rutgers University, New Brunswick, New Jersey 08903); DeWaard, H. Phys. Rev. C 9: No. 1, 326-330 (Jan 1974).

The mean life of the 77.3-keV level in ^{197}Au has been measured simultaneously in neutral gold atoms and in atoms with a mean charge of $\bar{q} = +9.5 \pm 1.5$. Mean lives of $\tau^0 = 2.76 \pm 0.03$ nsec and $\tau^{+9.5} = 2.84 \pm 0.12$ nsec were obtained. These results indicate that even the removal of 10 electrons from this atom does not affect the electronic structure of the inner shells, and therefore has little effect on the internal-conversion coefficients and lifetime of this nuclear state. These results are in good agreement with both relativistic and nonrelativistic calculations. (auth)

1661 LOW-SPIN STATES IN ^{200}Hg STUDIED WITH THE (n, γ) REACTION. Breitig, D.; Casten, R.F.; Cole, G.W. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 9: No. 1, 366-394 (Jan 1974).

The level scheme of ^{200}Hg has been studied by thermal and resonance neutron capture. The low-energy region has been measured with the high-resolution bent-crystal spectrometer at Risø, Denmark. The medium- and high-energy γ rays, coincidence spectra, and γ–γ angular correlations were measured at the Brookhaven National Laboratory (BNL) high flux beam reactor. Primary transitions from resonance capture in ^{199}Hg were studied with the fast chopper facility at BNL. Out of ~ 520 observed transitions, ~ 330 were placed in a level scheme containing 60 levels below 3.3 MeV. Many of these states are new and a great number of new I^π assignments was made. In particular $I^\pi = 0^+$ was assigned to a level at 1515 keV. Four 1^- states between 2.4 and 3 MeV are suggested. Possible explanations of their low excitation energy are offered. The simplest require and therefore suggest oblate shapes in ^{200}Hg, at least for excitations involving the unique parity orbitals. A very systematic behavior of the level feeding by nonprimary transitions was found in this nucleus and was compared to simple statistical predictions. A detailed comparison was made with model calculations for core-coupled proton states. The most likely candidates for these states are: 2^+_1 368 keV, 2^+_2 1254 keV, 2^+_3 1573 keV, 0^+_2 1515 keV, 1^+_1 1570 keV, 3^+_1 1659 keV. The possibility of a reduced central density of ^{200}Hg is discussed. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 1630, 1636, 1685, 1688, 1716, and 2099.

1662 (COO-1716-17) THERMODYNAMIC STUDIES ON HEAVY ELEMENTS AND STUDIES IN NUCLEAR CHEMISTRY. Final Report, February–December 1973. Cobble, J. W. (ed.). (Purdue Univ., Lafayette, Ind. (USA). Dept. of Chemistry). Mar 1974. Contract AT(11-1)-1716. 51p. Dep. NTIS $5.75.

The report summarizes research carried out during the year 1973 in the area of heavy-ion reactions (including fission) with Th and U. As this is a final report under this contract, a brief summary of all activities carried out during the last eighteen years is also included. Papers with significant amounts of data have been title listed separately. (RWR)

For title listings of individual papers see: 1663–1665.

1663 (COO-1716-17, pp 2-12) BINARY AND TERNARY FISSION YIELDS INDUCED BY ^{12}C AND ^{20}Ne IONS ON ^{238}U. Otto, R. J. Mar 1974.

In thermodynamic studies on heavy elements and studies in nuclear chemistry.

1664 (COO-1716-17, pp 15-19) SPALLATION REACTIONS OF ^{6}Li WITH ^{238}U. Rudy, R. C. Mar 1974.

In thermodynamic studies on heavy elements and studies in nuclear chemistry.

1665 (COO-1716-17, pp 20-29) HEAVY ION FISSION OF ^{232}Th BY ^{12}C IONS. Kasner, M. L. Mar 1974.

In thermodynamic studies on heavy elements and studies in nuclear chemistry.

1666 (COO-3058-44, pp 4) NUBAR RATIOS AT THERMAL ENERGIES FOR ^{233}U, ^{235}U, AND ^{239}Pu. Hockenbury, R. W. [nd].

In linear accelerator project. Progress Report, October 1–December 31, 1973.

1667 (IAEA-R-725-F) EMISSION OF LONG-RANGE ALPHA PARTICLES AND LIGHT CHARGED NUCLEI IN THE N-THERMAL FISSION AND RELATED TOPICS. Final Report, 1 March 1969–31 March 1972. Pinelli, T. (International Atomic Energy Agency, Vienna (Austria)). Jun 1972. 16p. INIS.

The energy spectra and yields of various long-range particles released in the thermal-neutron-induced fission of ^{233}U, ^{235}U and ^{239}Pu were measured. For spontaneous fission of ^{252}Cf, the energy spectra of fission fragments in coincidence with emission of helium isotopes were determined. Different light charged particles were identified by measuring the total kinetic energy and the energy loss rate with a solid state telescope detector consisting of two silicon detectors, 20 to 30 μm and 500 μm thick. For ^{233}U, the energy spectra of ^{6}He and ^{4}He emitted in fission were obtained. In case of ^{235}U fission, the ^{3}H, ^{4}He and ^{6}He energy spectra were determined in coincidence with a single fission fragment. ^{3}H and ^{6}He energy spectra and the angular distributions of alpha and ^{6}He particles were measured in ^{239}Pu thermal fission. By using these experimental data, several conclusions on dynamic conditions of the nucleus at scission point were drawn. (13 figures, 5 tables) (INIS)

1668 (WAPD-TM-1132) THERMAL SCATTERING CROSS SECTIONS OF ^{233}U AND ^{232}Th (LWBR DEVELOPMENT PROGRAM). Green, L.; Mitchell, J. A. (Bettis Atomic Power Lab., Pittsburgh, Pa. (USA)). Mar 1974. Contract AT-11-1-GEN-14. 15p. Dep. NTIS $4.00.

Scattering cross sections were measured for ^{233}U and ^{232}Th metal samples in a moderated spectrum from a 5-milligram ^{252}Cf source. The scattered neutrons were detected by two ^{3}He detectors in an annular geometry. The experimental data were corrected for thermal and epithermal fissions, epithermal scattering, air scattering, room background, and self-absorption. The self-absorption corrections for the four ^{233}U targets, covering a wide range in thickness, were obtained from Monte Carlo calculations. Corrections for the two ^{232}Th targets used were obtained experimentally. The results obtained were 12.30 ± 0.70 barns for ^{233}U and 12.78 ± 0.30 barns for ^{232}Th, relative to vanadium with an assumed scattering cross section of 5.02 ± 0.10 barns. The corresponding values in the ENDF/B-III file are 14.06 and 11.82 barns, respectively. (9 figures, 5 tables) (auth)

1669 α DECAY OF ORIENTED ^{237}Np NUCLEI. Gonin, N. N.; Kozlovskii, L. K.; Stavisskii, Yu. Ya.; Tambovtsev, D. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 78-79(Jan 1974). (In Russian).

The anisotropy of the flight of α particles from oriented ^{237}Np nuclei was studied in a wider range of degree of orientation than in previous studies. The alignment was accomplished in an intracrystalline field of monocrystals of the uranyl rubidium nitrate type cooled to 0.07°K. A fair agreement of the results was obtained with the values of the anisotropy calculated by the Hill–Wheeler method. (1 figure) (tr-auth)

1670 RELATIVE AND ABSOLUTE MEASUREMENTS OF THE FAST-NEUTRON FISSION CROSS SECTION OF ^{235}U. Poenitz, W. P. (Argonne National Lab., IL). Nucl. Sci. Eng.; 53: No. 4, 370-392(Apr 1974).

Measurements of the dependence of the ^{235}U fission cross section on neutron energy were carried out in the energy range from 35 keV to 3.5 MeV. Three different techniques were applied to monitor the neutron flux. The $^{6}Li(n,\alpha)T$ cross section was utilized in the lower energy range (<110 keV). The grey neutron detector was employed in the entire energy range, and the black neutron detector was used above 400 keV. The shapes were normalized with the results obtained from three different sets of absolute cross-section measurements. The associated activity technique was applied in the 450- to 650-keV range, the black neutron detector was used for absolute flux measurements at 800 keV and 3.5 MeV, and a calibrated vanadium bath was used at 500 keV. The results from the present measurements agree well with more recent data obtained by other experimenters, but differ up to a factor of 2 from older values. (16 figures, 12 tables, 82 references) (auth)

1671 ASSESSMENT OF PROPOSED $(n,\gamma n')$ DATA BASED ON MEASURED AND CALCULATED NEUTRON SPECTRA IN URANIUM DEPLETED IN ^{235}U. Becker, M.; Kaushal, N. N. (Rensselaer Polytechnic Inst., Troy, NY). Nucl. Sci. Eng.; 53: No. 4, 487-488(Apr 1974).

It is demonstrated that proposed $(n,\gamma n')$ data for ^{238}U cause substantially greater discrepancies to appear between measured and calculated spectra in uranium depleted in ^{235}U than have been observed without these data. It is concluded that these data should not be introduced into evaluated data files. (2 figures) (auth)

1672 SUB-BARRIER FISSION PROBABILITY FOR A DOUBLE-HUMPED BARRIER. Lynn, J. E.; Back, B. B. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Phys., A (London); 7: No. 3, 395-409(11 Feb 1974).

The interpretation of data on the decay of actinide nuclei by the fission process at excitation energies below the fission barrier is considered. It is shown that the intermediate structure (class-II levels), introduced into the fission strength function by the presence of a secondary well in the potential energy of deformation through the fission barrier, has a decisive effect in reducing the probability of fission decay at these energies. It is indicated how fission barrier parameters may be extracted from the data. Some actual examples given in this paper demonstrate the existence of an odd–even effect in fission barrier heights relative to the nuclear ground state. (auth)

1673 SHAPE ISOMERISM AND NUCLEAR STRUCTURE. Arlt, R. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 746-747(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1674 NEW LOOK AT THE LEAD ISOTOPE GROWTH CURVE. Oversby, V. M. (Australian National Univ., Canberra). Nature (London); 248: No. 5444, 132-133(8 Mar 1974).

The single stage lead growth model for lead produced from uranium isotopes is discussed, together with the variables involved in the calculation of single stage growth curves, and the influence of the most recent decay constants for U. Two apparent paradoxes associated with the single stage growth curve disappeared when using the new decay constants. (UK)

1675 SYMMETRIC FISSION IN THE NEUTRON-INDUCED FISSION OF ^{255}Fm. Ragaini, R.C.; Hulet, E.K.; Lougheed, R.W.; Wild, J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Rev. C 9: No. 1, 399-406 (Jan 1974).

The kinetic energy distributions of coincident fission fragments from the thermal-neutron-induced fission of ^{255}Fm and ^{251}Cf have been measured with phosphorus-diffused silicon detectors. The most probable values for the postneutron total kinetic energy are 192.5 ± 2.9 MeV for ^{255}Fm and 182.1 ± 2.7 MeV for ^{251}Cf. Fragment mass distributions were calculated without applying neutron emission corrections. The resultant mass and kinetic energy distributions for ^{255}Fm indicate a predominantly asymmetric mass division combined with appreciable symmetric fission. Fragment pairs near mass symmetry were found to be unusually energetic, which is a characteristic shared with symmetric fission in ^{257}Fm and ^{256}Fm. These results are well described by the two-center model of fission. Thermal-neutron-induced fission cross sections were measured as 3400 ± 170 b for ^{255}Fm and 4800 ± 250 b for ^{251}Cf. (auth)

1676 SEARCH FOR SUPERHEAVY ELEMENTS. Behringer, K.; Grütter, A.; von Gunten, H.R.; Schmid, A.; Wyttenbach, A. (Eidgenoessisches Institut fuer Reaktorforschung, CH-5303 Wuerenlingen, Switzerland). Phys. Rev., C; 9: No. 1, 48-55 (Jan 1974).

The spinner technique was used for a search for superheavy elements in chemical compounds, minerals, and in targets which were irradiated with 24-GeV protons. For minerals and chemical compounds upper limits for the concentration of eka-elements of 10^{-13}–10^{-14} g per gram of the homolog element were obtained, assuming a half-life for spontaneous fission of 10^{9} yr. Production cross sections of the order of 10^{-39} cm^{2} were established as upper limits for the formation of eka-elements and actinides in tungsten targets irradiated by high-energy protons, if half-lives of one year are assumed. (auth)

1677 ALPHA-PARTICLE ENERGY SPECTRUM ASSOCIATED WITH ^{252}Cf SPONTANEOUS FISSION. Loveland, W. (Oregon State University, Corvallis, Oregon 97331). Phys. Rev. C 9: No. 1, 395-398 (Jan 1974).

Using a counter telescope assembly, the fission α-particle spectrum associated with the spontaneous fission of ^{252}Cf was remeasured. No evidence was seen for any large number of short-range fission α-particles emitted at the instant of scission. The shape of the α-particle energy spectrum is quasi-Gaussian but shows more low-energy particles than would be predicted by a Gaussian shape. The shape of the α-particle energy spectrum and angular distribution are well described by a simple three-point charge-trajectory calculation. The parameters resulting from this calculation indicate that the fission fragments are well separated (~ 23 fm) and possess significant kinetic energies (heavy-fragment kinetic energy of 25 MeV) at the moment of appearance of the α particle. (auth)

1678 REEVALUATION OF EXPERIMENTAL ESTIMATES OF THE PAIRING GAP AT THE FISSION SADDLE POINT. Britt, H.C.; Huizenga, J.R. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). Phys. Rev. C 9: No. 1, 435-436 (Jan 1974).

New estimates for the height of the fission barriers imply new values for the pairing gap at the deformation corresponding to the second saddle points. Current barriers imply $2\Delta_s = 1.7 \pm 0.3$ MeV and 1.6 $\pm$ 0.3 MeV for ^{236}U, and ^{240}Pu, respectively. Uncertainties in the reported values of $2\Delta_s$ for ^{210}Po and ^{227}Ra are also discussed. (auth)

1679 ABNORMAL CHARACTER OF THE γ SPECTRA FROM (n,γ) REACTIONS OF SLOW NEUTRONS ON NUCLEI WITH A APPROX. 200. Orlova, V. V.; Rudak, E. A.; Khil'manovich, A. M. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 111-114(1973). (In Russian).

The possibility of evaluating the radiation width of γ transitions of nuclei from the capture state in (n,γ) reactions in the final level is examined. Attempts are made to explain the abnormal character of the γ spectra of the first cascade from slow neutron reactions on nuclei with A ~ 200. (tr-auth)

Nuclear Theory

Refer also to abstracts 1026, 1233, 1470, 1566, 1599, 1603, and 1636.

1680 (BNL-18747) PION-NUCLEUS INTERACTION. Dover, C. B. (Brookhaven National Lab., Upton, N. Y. (USA)). Mar 1974. 43p. Dep. NTIS $5.25.

The discussion covers the interaction of external probes with nuclei, classes of probes and their uses, types of nuclear structure information obtainable from an analysis of processes involving pions, theoretical ideas on the question of how the presence of the nucleus modifies the effective πN scattering amplitude in the medium, and the application of the techniques of many-body field theory. (JFP)

1681 (CONF-721231-PA, pp 141-153) PRESENT STATE OF NUCLEAR STRUCTURE RESEARCH. Warke, C. S. (Tata Inst. of Fundamental Research, Bombay). 1972.

From nuclear physics and solid state physics symposium; Chandigarh, India (28 Dec 1972).

Some current problems in nuclear structure research are discussed (i.e., new phenomena observed in the 1969-72). The principle areas examined are the following: α-particle core-excited threshold states and quartet structures of excited nuclear states, yrast states, quasi-molecular states, double analog states in the heavy mass region, isospin splitting of the giant dipole state, polarization phenomena in nuclear reactions, and borderline problems of high-energy and nuclear physics. (RWR)

1682 (UCRL-51538) VARIATION OF Z_p IN FISSION WITH CHANGES IN EXCITATION ENERGY AND COMPOUND NUCLEUS. Nethaway, D. R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Feb 1974. Contract W-7405-Eng-48. 25p. Dep. NTIS $4.00.

A least-squares technique was used to correlate all of the fractional chain yield data available for neutron-induced fission. The analysis is a modification of a method in which the $Z_p(A)$ function for thermal-neutron fission of ^{238}U is used as a reference, and values of ΔZ_p are calculated for other fissioning systems. In this method it is assumed that Z_p for a given fission-product mass chain depends mainly on the neutron/proton ratio in the fissioning nucleus, and that the charge dispersion curve for a given mass chain does not change from one type of fission to another. The coefficients in the equation $\Delta Z_p = a(Z_c - 92) + b(A_c - 236) + c(E^* - 6.52)$ were obtained from a least-squares analysis of the available independent and cumulative fractional chain yield data. It was found that separate sets of the coefficients a and b are needed for mass numbers in the two peaks of the mass-yield distribution. The value of c was found to have a strong dependence on the fission-product mass number, which can be correlated with mass-dependent changes in prompt-neutron emission with excitation energy. The model used for calculating ΔZ_p is surprisingly successful; the calculated values of Z_p generally agree with those inferred from the measured fractional chain yields within the uncertainty associated with the reference Z_p function. The average difference is 0.08 ± 0.01 charge unit. The measured independent yields from low-energy fission of even-Z elements exhibit an odd-even effect in which the yields of even-Z products are enhanced and the yields of odd-Z products are reduced. The magnitude of the effect is about ±14% from the mean, a little less than that found previously for thermal-neutron fission of ^{235}U. The results have too much scatter for a very precise determination. This effect has been explained as being due to proton pairing in both fission fragments. The odd-even fluctuation is found to be absent in 14-MeV neutron-induced fission. (1 figure, 5 tables, 73 references) (auth)

1683 CHARGE INDEPENDENCE AND CHARGE SYMMETRY OF NUCLEAR FORCES. Sliv, L. A. (Leningrad Inst. of Nuclear Physics). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 2-14(Jan 1974). (In Russian).

An examination of the problem of the charge independence of nuclear forces is reported, and some basic conclusions are formulated. The bare nuclear forces are charge independent. The different dynamic electromagnetic effects appearing in the process of meson exchange between nucleons leads to a breakdown of the charge independence of the nuclear force of about 2%, and the charge symmetry is smaller by about 1%. A generalized form of the nuclear potential is given. The scattering lengths in the ^1S state are $a_{np} = 23.7146 \pm 0.0127$ fermi, $a_{pp} = 17 \pm 1$ fermi, and $a_{nn} = 18.5 \pm 1.5$ fermi. The precision of the determination of a_{nn} and a_{pp} should be increased. (8 figures, 5 tables) (JSR)

1684 JUSTIFICATION OF THE OPTICAL MODEL FOR EVEN-EVEN DEFORMED NUCLEI. Knyaz'kov, O. M. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 105-107(Jan 1974). (In Russian).

The scattering of nucleons on even-even deformed nuclei was examined in the weak-coupling scheme of the semiphenomenological model. From the complete interaction of the nucleon with the target nucleus the average field potential and the residual interaction were separated. In the framework of the perturbation theory on the residual interaction the absorption potential was constructed. Calculations were made of the contribution of the 2^+0 state to the imaginary part of the optical potential in the local approximation. It was concluded that the contribution of the 2^+0 state to the absorption potential at E = 16 MeV for the ^{156}Gd target nucleus is ~ 30%. (1 table) (tr-auth)

1685 ELECTRON PARAMETERS FOR ANGULAR CORRELATIONS OF L CONVERSION ELECTRONS IN MIXED E0 + M1 + E2 TRANSITIONS. Listengarten, M. A. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 15-24(Jan 1974). (In Russian).

Expressions were obtained for the E0E2 interference terms of the angular correlation functions for the general case and for the special case of conversion in L_I and L_{II} shells (b_2^{LI} (E0E2) and b_2^{LII} (E0E2)) and for the averaged parameters for the L shell as a whole ($b_2^{\overline{L}}$ (E0E2)). Questions on the sign of the interference terms were discussed. Tables were given for the values of b_2 for $49 \le Z \le 98$ and $0.05 \le k \le 0.7$. (1 figure, 3 tables) (tr-auth)

1686 GENERALIZED TAMM-DANCOFF METHOD IN THE NUCLEAR THEORY. Sysoeva, S. A.; Tsekhmistrenko, Yu. V. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ Ed.); 19: No. 1, 7-15 (Jan 1974). (In Russian).

A new method is proposed to calculate the nuclear spectra and nucleon scattering cross sections. It takes into account the dependence of one-particle Hamiltonian eigenfunctions of self-consistent field on the nuclear system state. Numerical calculations are performed for energies of low lying 0^+ levels as functions of the coupling constant in case of particular residual interaction. (auth)

1687 EXPERIMENTAL TESTS OF GOTTFRIED'S MODEL FOR MULTIPLE PRODUCTION OF PARTICLES IN HADRON-NUCLEUS COLLISIONS. Holynski, R.; Krzywdzinski, S.; Zalewski, K. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol.; B5: No. 2, 321-326(1974).

Gottfried's theory of multiple production of particles in hadron-nucleus collisions is compared and found consistent with experimental data. The theory and the data are used to predict the inclusive distribution in $-\ln \tan \Theta_{lab}/2$ for particles produced in proton-arbitrary nuclear target collisions at 67 and 200 GeV/c incident momentum. (auth)

1688 STATES OF NEGATIVE PARITY IN EVEN–EVEN NUCLEI. Begzhanov, R. B.; Belenkii, V. M.; Usharov, V. K. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 93-100(Jan 1974). (In Russian).

A collective model with asymmetric rotation describing levels of negative parity in deformed even–even nuclei was examined. A new method was proposed for the approximate separation of quadrupole and octupole variables. This model used the method developed in the rotational–vibrational theory of Faessler and Greiner for quadrupole excitation. The level schemes calculated for a series of nuclei (^{162}Dy, ^{168}Er, ^{228}Th, ^{230}Th, and ^{232}U) were compared with experimental data. (5 figures) (tr-auth)

1689 BETA-DECAY NUCLEAR MATRIX ELEMENTS WITH MICROSCOPICALLY CALCULATED NUCLEAR WAVE FUNCTIONS ILLUSTRATED FOR THE EXAMPLE OF ^{148}Pm. Krinn, H. Stuttgart; Stuttgart Univ. 119p. (In German).

Thesis.

The thesis is divided into four parts. In the first part, Bohr's phenomenological Hamilton operator is verified and substantiated by a theory according to which the interaction of the nucleons proceeds via a pair-plus-quadrupole force. In the second part, the quantization of Bohr's Hamilton operator is described, and the method of diagonalization and the eigenvectors are given. The eigenstates are derived from the phonon states calculated by the quasi-particle random phase approximation (QRPA). In order to be able to describe the odd–odd nucleus, odd quasi particles are coupled. Based on the wave functions derived in the second part, the nuclear matrix elements are calculated explicitly for the first-forbidden β decay. Furthermore, the interrelation between the nuclear matrix elements and the measurable parameters of the β decay is outlined. In the last part, the parameters used for the numerical calculations are given, and the results of the calculations for the beta decay matrix elements are shown in a table. (13 tables) (tr-auth)

1690 SINGLET DEUTERON IN THE (p,pn) REACTION. Avakov, G. V.; Belyaeva, E. S.; Dolinskii, E. I. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 120-124 (Jan 1974). (In Russian).

The problem of the formation of the singlet deuteron in (p,pn) reactions on complex nuclei was examined. The reaction amplitude in the peripheral model in the pole approximation (neutron knock-out mechanism) was calculated. The neutron–proton scattering amplitude at low energies was calculated in the effective-range approximation. The calculations made with the theoretical formulas were compared with experimental data for the reaction ^{7}Li(p,pn)^{6}Li (g.s.) at 12 MeV and for ^{9}Be(p,pn)^{8}Be (g.s.) at 12 and 17 MeV. Good agreement with experimental data was obtained. (3 figures, 1 table) (tr-auth)

1691 RELATIONSHIPS BETWEEN EXPERIMENTAL AND THEORETICAL PARAMETERS IN UNRESOLVED RESONANCE THEORY. Gyulassy, M.; Perkins, S. T. (Univ. of California, Livermore). Nucl. Sci. Eng.; 53: No. 4, 482-486(Apr 1974).

The usual derived relations between the orbital angular momentum and the spin dependence of the unresolved resonance parameters are investigated, and the basic underlying assumptions are compared with the most recent experimental data. Because of the lack of p-wave data, however, only the assumptions pertaining to s-wave parameters can be verified. Furthermore, it is shown that a previously used level density expression between $\rho(l)$ and $\rho(l,J)$ as used by some authors—assuming a (2J + 1) dependence—is in error. (1 figure, 2 tables) (auth)

1692 ACCURATE Nth-ORDER ITERATIVE METHOD FOR NONLINEAR OSCILLATORS. Henkel, J. H.; Uzes, C. A. (Univ. of Georgia, Athens). Phys. Rev., D; 8: No. 12, 4430-4437(15 Dec 1973).

The raising and lowering properties, the canonical commutation relation, and the equation of motion for the displacement operator for the one-dimensional nonlinear oscillator are used to define Nth-order iterative approximations for transition frequencies. In contrast to other approximation methods the orders of approximation are suggested by the commutation relation. It is numerically shown that the iterative approximation yields better results than low-order methods; the fourth-order approximation yields eigenfrequencies accurate to one part in 10^5 for the fourth-degree oscillator. It is concluded that in low-order approximations it is more important to take into account the commutation relations and thus adjacent-level frequency variations than higher-order matrix elements as is done in Rayleigh–Schroedinger perturbation theory. (auth)

1693 SCHEME OF THE APPROXIMATE RELATIVISTIC THEORY OF THE NUCLEUS. I. Calculation of the Single Particle Basis Hamiltonian from Internucleon Interactions. Krutov, V. A.; Fomenko, V. H.; Savushkin, L. N. (Leningrad State Univ.). J. Phys., A (London); 7: No. 3, 372-382(11 Feb 1974).

The approximate relativistic equation (relativistically invariant to within terms in v^2/c^2) for a system of nucleons is used in this paper as the starting point to obtain the nuclear average field, isobaric-spin potential and spin–orbit potential. Calculations are carried out in the framework of the Hartree–Fock approximation. Accounting for the wavefunction of proper symmetry noticeably improves the agreement with experiment. The nuclei ^{41}Ca and ^{209}Pb are considered for illustration, different variants of the two-particle interactions of the OBEP type being utilized. (auth)

1694 WEAK-COUPLING COLLECTIVE CONTRIBUTION TO ODD–ODD NUCLEAR MAGNETIC MOMENTS. Callaghan, P. T. (Oxford Univ.). J. Phys., A (London); 7: No. 3, 383-387(11 Feb 1974).

It is found for the weak-coupling case of the Bohr and Mottelson collective model that the inclusion in the Landé-formula single-particle g factors of core rotation effects gives an incorrect contribution to the odd–odd nuclear moment. A correction term is proposed. (auth)

1695 NONSTATISTICAL EFFECTS DURING INELASTIC SCATTERING OF LOW-ENERGY NEUTRONS. Konobeevskii, E. S.; Musaelyan, R. M.; Popov, V. I.; Surkova, I. V. (Inst. of Nuclear Research, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 149-155(Jan 1974). (In Russian).

Experimental data on the inelastic scattering cross section of neutrons near the threshold for the excitation of the first 2^+ level of even–even spherical nuclei in the region A ~ 50 to 150 and A ~ 200 were examined. The results of the analysis showed that in the region A ~ 70 to 80 (Ge, Se) the experimental values greatly exceed the values predicted by the statistical theory. (3 figures) (tr-auth)

1696 NUCLEON DECAY OF DOORWAY STATES. Devyatko, Yu. N.; Zaretskii, D. F.; Urin, M. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 125-127(Jan 1974). (In Russian).

Analysis of the experimental data on proton widths of analog resonances on the basis of the shell approach to the theory of nuclear reactions made it possible to reach quantitative conclusions on the size of the spectroscopic factors (SF) for the ground and low-lying states of nuclei with a large neutron excess. Consideration of the radial dependence of the Lane potential leads to quantitative conclusions on the size of SF. Since the one-particle width of the doorway states essentially depends on the parameters of the optical potential, these parameters must be determined in order to describe the dependence of the reaction cross section at corresponding energies. The description of the analog resonances on the basis of the shell approach makes it possible to calculate the possible use of this approach for the description of resonance reactions with excitation of other doorway states (giant dipole resonance, isolated configurations of the 2-particle–1-hole type, etc.). (1 table) (JSR)

1697 CORRELATION EFFECTS IN THE INTERNAL BREMSSTRAHLUNG ACCOMPANYING β DECAY OF NUCLEI. Almaliev, A. N.; Batkin, I. S. (Voronezh State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 108-115(Jan 1974). (In Russian).

A general expression was found for the density matrix of the process of emission of internal bremsstrahlung quanta. With it formulas were obtained for the correlation of the bremsstrahlung and subsequent γ radiation, for β–γ angular correlations, and for the angular distribution of bremsstrahlung from polarized sources. The effect of internal bremsstrahlung on the different β decay characteristics of the nucleus was also calculated. (tr-auth)

1698 PSEUDOPOTENTIAL METHOD IN PROBLEMS ON DENSITY OF STATES. Ignatyuk, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 172-175(Jan 1974). (In Russian).

The effect of the interaction of particles (differing in pairing correlations) on the behavior of the statistical character of the excited nucleus is examined. It is shown that the exchange part of the effective interaction can significantly reduce the size of the parallel moment of inertia determining the spin dependence of the level density of the excited nucleus. (tr-auth)

1699 GENERALIZED MODEL OF DIRECT AND RESONANCE NUCLEAR REACTIONS. Ol'khovskii, V. S. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 38: No. 1, 165-171(Jan 1974). (In Russian).

A model based on the K-harmonic method was formulated to describe direct and resonance nuclear reactions. The model is illustrated by a study of the nature of the resonance in the cross section for scattering of neutrons by ^{12}C in the energy range from 15.8 to 19.6 MeV. (JSR)

1700 POLAR EMISSION AND EVAPORATION FROM FISSION FRAGMENTS. Piasecki, E.; Blocki, J. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol.; B5: No. 2, 247-294(1974).

The problem of fission fragment deexcitation through the charged particle evaporation channel was investigated using the statistical angular momentum dependent model. The anticipated intensities of emission and the energy spectra of p, d, t, ^{3}He, ^{4}He, and ^{6}He, evaporated from the ^{235}U fission fragments were calculated. The results regarding α-particles explain to some extent the "polar emission" phenomenon. Assuming that the "polar" α-particles are evaporated in flight from the excited fragments the mean experimental mass of the α-emitting light fragments can be reproduced theoretically. Similarly, the α-particle energy spectrum and the intensity of emission from the heavy fragments are explained quantitatively without parameter fitting. The energy spectrum of alphas going along the light fragment trajectory can be explained if the fragment deformation is taken into account. The intensity of the last mentioned alphas and the large anisotropy of the polar alphas angular distribution can be explained only by assuming a very low value of the moment of inertia or a high angular momentum of the fragments. Suggestions are given as to carrying out further experiments as well as making use of this phenomenon in the study of fission fragment properties and in testing the statistical model of reactions. (auth)

1701 EQUILIBRIUM DEFORMATIONS AND THE QUADRUPOLE 0^+ AND 2^+ VIBRATIONAL STATES IN EVEN ISOTOPES OF W, Os, AND Pt. Gabrakov, S. (Univ., Sofia); Kaniowska, T.; Zielinska-Pfabe, M. Acta Phys. Pol.; B5: No. 2, 295-307(1974).

The theoretical quadrupole and hexadecapole ground state equilibrium deformations and deformation energies are calculated by the method of summation of the single-particle energy levels, for even tungsten, osmium and platinum isotopes. They are in a good agreement with the known experimental data. The reduced transition probability B(E2), and Rasmussen parameter for the one-phonon vibrational 0^+ and 2^+ states are calculated for the same elements, in the framework of the "quasiboson" approximation. The results show that with the use of proper quadrupole and hexadecapole equilibrium deformations of the nucleus one is able to fit the experimental data for tungsten and osmium quite satisfactorily, while for platinum isotopes this method fails. (auth)

1702 SCATTERING AMPLITUDE FOR STRONGLY ABSORBING NUCLEI IN THE COMPLEX ANGULAR MOMENTUM APPROACH. Anni, R.; Taffara, L. (Univ., Lecce, Italy). Nuovo Cim.; 20A: No. 4, 595-612(21 Apr 1974).

The complex angular-momentum approach of the strong-absorption model (SAM) is discussed for small scattering angles too. In particular, it is observed that the method works in the whole angular range. For $\theta < \theta_c$, however, the series of the residues at the poles of the nuclear partial-wave scattering amplitude is not rapidly convergent and, in contrast with the usual hypothesis, the background integral is no longer negligible. The correct behavior of the SAM cross section at small angles arises then just from the sum of the contribution of the series of the residues with the background integral. Owing to this fact, the complex angular-momentum approach becomes impractical in order to obtain a simple form of the SAM cross section for $\theta < \theta_c$. An approximate expression of the scattering amplitude can be however obtained by means of a suitable deformation of the integration path in the complex plane of the angular momentum and by using the steepest-descent method. (auth)

1703 REPULSIVE CORE EFFECTS VIA DIRECT REACTIONS. Osman, A.; Zaky, M. (Cairo Univ.). Atomkernenergie; 22: No. 3, 208-213(Dec 1973).

Short-range correlations are considered in one- and two-nucleon-transfer reactions. The nucleon–nucleon interaction is introduced as a short-range potential surrounded by a long-range potential. A Gaussian form is taken for both the repulsive and attractive parts of the potential, and the form factors for (d,p) and (t,p) reactions are calculated. The results show the importance of considering the repulsive cores in extracting the spectroscopic factors. (10 figures, 5 tables) (auth)

1704 MOCA: A MONTE CARLO PROGRAM TO CALCULATE THE INFLUENCE OF ABSORPTION AND MULTIPLE SCATTERING ON THE ENERGY SPECTRUM OF INELASTICALLY SCATTERED NEUTRONS. Hermsdorf, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 705-706 (1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1705 ELIESE-2: A HAUSER–FESHBACH PROGRAM FOR THE CALCULATION OF INELASTIC EXCITATION CROSS SECTIONS. Hoehn, J.; Kiessig, G. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 708(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1972). See CONF-711157-.

1706 LEVEL DENSITY OF NUCLEAR NEAR THE $f_{\frac{7}{2}}$ SHELL AND THE $d_{\frac{5}{2}}$ SUBSHELL. Seeliger, D.; Seidel, K. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 714-716(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1707 CALCULATION OF THE DENSITY OF STATES IN THE SINGLE-PARTICLE MODEL. Hermsdorf, D.; Seeliger, D.; Seidel, K. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 716-718(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1708 RESONANCE REACTIONS IN THE CONTINUUM SHELL MODEL. Barz, H. W. (ZIK, Rossendorf, Ger.). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 733-736(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1709 THEORETICAL BASIS FOR A STATISTICAL DESCRIPTION OF NUCLEAR REACTIONS. Reif, R. (ZIK, Rossendorf, Ger.). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 738-740(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1710 MODERN MODEL CONCEPTIONS FOR THE DESCRIPTION OF THE TRANSITION TO THE STATISTICAL EQUILIBRIUM STATE IN NUCLEAR REACTIONS. Seeliger, D. (Technische Hochschule, Dresden). Wiss. Z. Tech. Univ. Dresden; 21: No. 4, 740-746(1972). (In German).

From international seminar on questions of nuclear structure research with neutrons; Gaussig, German Democratic Republic (29 Nov 1971). See CONF-711157-.

1711 ADVANCES IN NUCLEAR PHYSICS. Volume 6. Baranger, M.; Vogt, E. (eds.). New York; Plenum Publishing Corporation (1973). 473p. $25.00.

Separate abstracts were prepared for each of the three chapters in this volume. (RWR)

For abstracts of individual chapters see: 1712–1714.

1712 NUCLEAR FISSION. Michaudon, A. (CEN, Saclay, France). Advan. Nucl. Phys.; 6: 1-217(1973).

Developments in nuclear fission during the last several years are reviewed. Conventional theories of fission are first recalled, with special emphasis on the liquid drop model and the channel theory of Bohr. Some experimental results that cannot be explained in terms of these conventional theories are presented, with emphasis on fission isomerism and intermediate structure in subthreshold fission cross sections. The calculation of fission barriers is then discussed, with the effect of shells taken into account at all deformations of the fissioning nucleus. For some nuclei double-peaked fission barriers are obtained. This result provides a basis for the interpretation of the experimental results previously discussed. (106 figures, 14 tables, 247 references) (RWR)

1713 MICROSCOPIC THEORY OF NUCLEAR EFFECTIVE INTERACTIONS AND OPERATORS. Barrett, B. R. (Univ. of Arizona, Tucson); Kirson, M. W. Advan. Nucl. Phys.; 6: 219-285 (1973).

After a brief introduction the general theory is presented, including the time-dependent derivation, the time-independent derivation, Brueckner theory, and the algebraic approach. Calculation of the effective two-body interaction is then discussed; perturbation calculations, nonperturbative calculations, and the convergence of the perturbation expansion are treated. Next, the calculation of the E2 effective charge is taken up. Effective charge in mass-17 nuclei, effects of the nucleon–nucleon force and single-particle potential, and other mass values are described. (29 figures, 9 tables, 115 references) (RWR)

1714 TWO-NEUTRON TRANSFER REACTIONS AND THE PAIRING MODEL. Broglia, R. A. (Univ. of Copenhagen); Hansen, O.; Riedel, C. Advan. Nucl. Phys.; 6: 287–457(1973).

The central theme of this work is the study of the nuclear pairing correlations and, in particular, the study of their dynamic implications, with two-nucleon-transfer reactions used as a probe. Only nuclei with masses over 40 are included. Most of the calcula-

tions are done with the pairing force, but results obtained with realistic force wave functions are also presented; and a critical comparison between the different calculations and the data is performed. The discussion begins with the distorted-wave Born approximation theory of two-neutron-transfer reactions; pertinent results necessary for the analysis of experiments are assembled in tables and figures. The data are then systematically presented, with the conspicuous trends of the strong transitions shown. The empirical rules to be used in obtaining spectroscopic information from (t,p) and (p,t) data are also given. Next, the monopole pairing model is presented, and the associated collective nuclear excitations are discussed. This model is then confronted with the experimental data; alternative descriptions of the states connected by strong transitions are also studied. The pairing model is then extended to the analysis of (t,p) and (p,t) transitions with $L \neq 0$, and evidence for the existence of multipole pair correlations is discussed. The picture is further extended to encompass the particle–hole modes (which may have large two-nucleon-transfer cross sections, the particle–pairing vibration coupling, and the phonon–phonon interaction in spherical nuclei. In addition, some of the effects caused by multistep (indirect) transitions are covered. There are also three appendices: the first one contains extensive data tabulations, the second gives a collection of useful expressions for the calculation of two-neutron spectroscopic amplitudes, and the last presents a detailed derivation of the pairing vibrational energies. (48 figures, 40 tables, 194 references) (RWR)

1715 RESONANT PION PROPAGATION IN NUCLEAR MATTER. Ohta, K. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 50: No. 4, 1424-1426(Oct 1973).

The lowest correction to the nucleon and pion propagators with a pseudoscalar pion field coupled to static nucleons in the medium is calculated for resonant pion propagation in nuclear matter. (JFP)

1716 THEORY OF NUCLEAR ROTATIONAL BANDS. Mikhailov, I.N.; Nadzhakov, E.; Karadzhov, D. (Joint Institute for Nuclear Research, Dubna). Sov. J. Part. Nucl. 4: No. 2, 129-147 (Oct 1973).

The effects which arise due to the rotation of deformed nuclei are briefly summarized. Methods for theoretically describing these effects based on quantum many–body theory are outlined. (auth)

1717 SCATTERING FROM CORRELATED SYSTEMS. Scheerbaum, R.R.; Shakin, C.M.; Thaler, R.M. (Department of Physics, Case Western Reserve University, Cleveland, Ohio, 44106). Ann. Phys. (N.Y.) 76: No. 2, 333-359 (Apr 1973).

A difficulty usually encountered in formulating the problem of scattering of identical particles from correlated systems is that the customary choice of an unperturbed Hamiltonian as the target Hamiltonian plus the kinetic energy of the projectile is not symmetric under particle exchange. This choice of unperturbed Hamiltonian leads to wavefunctions which, if they are antisymmetrized, are not orthonormal. In this paper an orthonormal, antisymmetrized set of basis states is constructed. These states are then used to construct a symmetric unperturbed Hamiltonian, so that a formal scattering equation with appropriate boundary conditions can be written. An expression for a T matrix describing nucleon–nucleus scattering can then be obtained. The formalism leads to a two–potential form for the T matrix, the first term of which describes the effect of the orthogonality of the scattering state and the negative energy states. (auth)

1718 THE QUANTUM THEORY OF NUCLEON CORRELATION IN FINITE NUCLEI. II. HIGHER ORDER CORRELATION EFFECTS AND ADDITIVE PAIR APPROXIMATION. Szasz, L. (Department of Physics, Fordham University, New York 10458); Schroeder, J. Ann. Phys. (N.Y.) 76: No. 1, 137-160 (Mar 1973).

In the first part of this article it was shown that the variational solution of the Schroedinger equation of a finite Fermion system can be written as a finite sum of A terms (for A particles) the first of which is the Hartree–Fock energy, while the rest represent the correlation effects. In the first part explicit formulas for the 2–particle correlation energy were given. In this paper explicit formulas are given for the higher order correlation energies. It is shown that two different models can be developed depending ôn the orthogonality condition used. Beginning with the 4th order effects the "linked" and "unlinked" correlation terms are separated. An exact formula is given for the case in which only the 2–particle effects, linked and unlinked are taken into account. The "additive pair approximation" in which the correlation energy is given as the sum of 2–particles energies is investigated and it is shown to be related to the exact formula by a clearly defined set of approximations. Various possible applications of the model are discussed. (auth)

1719 ON HIGH–ENERGY ELASTIC SCATTERING OF PROTONS BY NUCLEI. Lambert, E.; Feshbach, H. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts). Ann. Phys. (N.Y.) 76: No. 1, 80-115 (Mar 1973).

The two coupled channel formalism for high energy elastic scattering is extended to include spin and isospin effects. For a spin and isospin zero nucleus these manifest themselves by additional spin–orbit terms in the potentials. Explicit formulas for these potentials are obtained in terms of the fully spin and isospin dependent nucleon–nucleon scattering amplitude, the ground state nuclear form factor and the state dependent correlation functions. The coupling potential except for a small term arising from double spin and isospin flip process involving nuclear excitation depends only upon the pair correlations. Numerical calcualtions are performed for the elastic scattering 1 GeV protons incident on ^{4}He. Various phenomenological dynamical two–body correlations as well as correlations generated from the Reid soft–core and Tabakin potentials in an approximate Brueckner–Hartree–Fock calculation are considered. The angular distribution beyond its first diffraction minimum as well as the polarization in the same angular range is shown to be sensitive to these correlations. However, the present accuracy of the experimental data and the lack of knowledge of the nucleon–nucleon scattering amplitude prevent any definitive conclusion about their nature. (auth)

1720 RELIABILITY OF THE SEPARATION METHOD FOR THE EFFECTIVE INTERACTION IN INELASTIC SCATTERING. Redish, E.F.; Dixon, R.M. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. C 9: No. 1, 428-431 (Jan 1974).

The separation method of Moszkowski and Scott has recently been used to generate an effective interaction for inelastic scattering. We investigate this approximation for the two–nucleon $^1S_0$ state in a realistic model. We find that the method only yields reliable off–shell matrix elements for low energies and momenta near the on–shell point. (auth)

1721 SPECIFIC NEW APPROACH TO FINITE–RANGE DISTORTED–WAVE BORN APPROXIMATION. Charlton, L.A. (Department of Physics, The Florida State University, Tallahassee, Florida, 32306). Phys. Rev. C 9: No. 1, 413-413 (Jan 1974).

A new approach to finite–range distorted–wave Born–approximation calculations was given in a previous paper. This approach utilized plane–wave expansions of the distorted waves and required a testing procedure. A different method for testing these expansions is needed when large heavy ions are considered. This method is presented here. (auth)

1722 SIMPLE ESTIMATE OF DEFORMATIONS IN THE ALIGNED COUPLING SCHEME. Dasso, C.; Klein, A. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 9: No. 1, 414-415 (Jan 1974).

In the schematic model of a deformed nucleus in which all nucleons are confined to a single j shell (of large degeneracy), the intrinsic state generating the ground–state rotational band is defined by the aligned coupling scheme. A semiclassical evaluation valid for this scheme shows under what conditions the quadrupole deformation dominates over deformations of higher order. (auth)

1723 NUCLEAR REARRANGEMENT SCATTERING. I. QUASIFREE (p, 2p) REACTIONS. Scheerbaum, R.R.; Shakin, C.M. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 9: No. 1, 116-131 (Jan 1974).

A formal theory of scattering, including rearrangement processes, is presented. This theory is based on a model using completely antisymmetrized and orthogonalized channels. A detailed discussion of the (p, 2p) reaction which emphasizes the sequential amplitude for this process is given as an application of the formal theory. The single–hole state generated upon the first collision is discussed using an extension of the theory of intermediate structure to doorway states which are not in a space orthogonal to the space of continuum channels. The theory developed here is able to properly include off–shell and Pauli principle effects in the description of the reaction. Some of the approximations necessary to obtain the standard results for the (p, 2p) cross sections are also exhibited in the context of our general theory. (auth)

1724 VARIATIONAL METHOD FOR OFF–SHELL THREE–BODY AMPLITUDES. Brady, T.J. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742); Sloan, I.H. Phys. Rev. C 9: No. 1, 4-15 (Jan 1974).

A variational scheme of the Schwinger type, used successfully in a previous paper for calculating two–body t–matrix elements of all kinds (on shell, half shell, and off shell), is here applied to the three–body collision problem. Numerical results are given for the case of the Amado model of the N–d system. These results show excellent convergence properties, even for the case of fully off–shell amplitudes in the region where the analytic structure is most troublesome. It is shown theoretically that the three–body variational method, if restricted to the case of physical on–shell amplitudes, is formally equivalent to the several variational principles given by Pieper, Schlessinger, and Wright, though the methods may differ considerably in practice. The formal

equivalence is used to show that Pieper's recent perturbative calculations of N–d polarization, in which the zero-order problem was approached variationally, have a property not previously noted, namely that even the perturbed solution is fully variational. More generally, a useful degree of cooperation is shown to occur between the present variational method and the perturbation method, making it quite easy to preserve the variational property in a perturbative calculation. (auth)

1725 PION–NUCLEUS COORDINATE-SPACE POTENTIAL. Kisslinger, L.S. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213); Tabakin, F. Phys. Rev. C 9: No. 1, 188-199 (Jan 1974).

A first-order pion–nucleus optical potential which is convenient for the analysis of pion–nucleus data is presented. This configuration-space potential incorporates a number of important theoretical features. A Lorentz transformation of the pion–nucleon interaction from the pion–nucleon to the pion–nucleus center-of-mass system is shown to yield a first-order potential which is almost local in coordinate space, and which differs from the originally proposed gradient potential, by containing an additional term proportional to the Laplacian of the density. We then show how this form is modified by off-shell and high-energy considerations. It is emphasized that proper off-shell and threshold behavior can be included and that energy and momentum variables must be treated carefully in deriving the optical potential. Typical numerical results are given and the new potential is shown to yield a significant build-up of large-angle cross sections. (auth)

1726 INFLUENCE OF CORIOLIS INTERACTION ON THE MAGNETIC MOMENTS OF ODD-MASS NUCLEI. Antonyan, K. G.; Sardaryan, R. A. (Erevan Physics Inst.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 8: No. 3, 168-177(1973). (In Russian).

The magnetic moments of ground and excited states of rotational bands built on Nilsson orbitals are calculated for various values of the Coriolis coupling parameters. It is shown that Coriolis interaction may significantly influence the magnetic moments, especially for higher spin states. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

1727 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. Volume 8, No. 2, 1974. Bibliography, Author Index, Subject Index, Appendix. Leopoldshafen; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 48p. (In German and English).

1728 PLASMA PHYSICS INDEX. Thesaurus, 1974. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1974). 21p.

Confinement and Heating

1729 TIME DEPENDENCE OF TURBULENT RESISTIVITY IN A LINEAR PLASMA COLUMN. Schrijver, H. (FOM-Institut voor Plasmafysica, Jutphaas, Netherlands). Physica; 70: No. 2, 339-357(1 Dec 1973).

The plasma resistivity in a linear turbulent heating experiment is measured as a function of time. Plasma densities are varied between 10^{19} and 1.5×10^{20} m^{-3} in H, He, Ne, Ar, and Xe. The plasma turbulence is excited by applying electric fields along the plasma column of 10 to 45 kV m^{-1}. A strong correlation is found between the time dependence of the resistivity and that of the microwave radiation emitted by the plasma around ω_{pe}. An estimate is given of the electron temperature attainable from the energy dissipation due to the anomalously high resistivity. The expansion of the plasma column as a consequence of the heating and the ionization of neutral gas is discussed. (auth)

1730 TURBULENT RESISTIVITY IN HYDROGEN AND NOBLE-GAS PLASMAS. Schrijver, H. (FOM-Institut voor Plasmafysica, Jutphaas, Netherlands). Physica; 70: No. 2, 358-374(1 Dec 1973).

The resistivity of a plasma that has become turbulent under the influence of a high electric field is measured. The relations of the resistivity in the initial stage of turbulence with the parameters of the plasma are considered. The electric field along the plasma column extends from 10 up to 45 kV m^{-1}. Plasma densities are varied between 10^{19} and 1.5×10^{20} m^{-3} in H, He, Ne, Ar, and Xe. The plasma is confined in a magnetic mirror field of 0.4 to 1.5 T peak induction. A linear dependence is found between the resistivity and the applied electric field. The confining magnetic field has a negligible influence. At low densities (1 to 3×10^{19} m^{-3}) the resistivity is independent of the ion mass. At higher densities a mass dependence is found. The correlation between the resistivity and the level of electrostatic fluctuations, measured by means of microwave radiation emitted by the plasma, indicates a linear relation between the effective collision frequency and the fluctuation energy. From the agreement with the computer simulations of Biskamp and Chodura it is concluded that the saturation of the instabilities is caused by ion trapping. Nonlinear Landau damping is shown to be unimportant under the prevailing conditions. (auth)

Diagnostics

1731 USE OF AN H–F ANALYZER FOR MASS SPECTROMETRY AT HIGH PRESSURES. Lelegard, J. (EURATOM, Fontenay-aux-Roses, France). Vide; 2: No. 163, 20-26(Jan 1973). (In French).

The establishment of diagnostics for the study of the parameters of confined plasmas necessitates an extremely high degree of cleanliness: a very large pressure range was explored (10^{-3} to 10^{-9} torr). Three examples of the use of TOPATRON-B (which falls into the dynamical category) are given that involve the variations in ion energy with time defined by a high frequency oscillator. (FR)

1732 ION-ENERGY DISTRIBUTION IN A PLASMA UNDER A DIVERGING MAGNETIC FIELD. Hatakeyama, R.; Sato, N.; Tsunoda, Y.; Sugai, H.; Hatta, Y. (Department of Electronic Engineering, Tohoku University, Sendai, Japan). J. Appl. Phys. 45: No. 1, 85-88 (Jan 1974).

A distribution function of ion energy parallel to a magnetic field is measured to be deformed along a diverging magnetic field in a single-ended Q machine. The deformation is well explained by the orbit theory for a collisionless plasma. (auth)

Kinetics (General)

1733 FORMATION OF PLASMA EQUILIBRIUM IN A Q-MACHINE WITH RADIAL POTENTIAL DISCONTINUITIES. Searing, R. M. (Univ. of California, Livermore). Plasma Phys.; 16: No. 4, 385-405(Apr 1974).

A potassium-ion plasma forms in a Q-machine with mirror magnetic fields at the hotplates. Discontinuity in the thermoelectric potential at the hotplate edge produces a strong localized radial electric field that both electrostatically confines the ions and creates a high-velocity rotating annulus. Neglecting time-dependent losses, the radial equilibrium in the collisional regime with the column radius comparable to the ion gyro radius was adequately described by an isothermal single-fluid model, including both ion viscosity and rotational inertia. The radial density profiles were consistent with classical diffusion at the column edge. (auth)

Kinetics (Experimental)

1734 INTERACTION OF A PLASMA BEAM WITH A MAGNETIC BARRIER. Lee, J. J. Cleveland; Case Western Reserve Univ. (1973). 122p. University Microfilms Order No. 74-2539.

Thesis (Ph.D.).

A supersonic He plasma beam (200 eV, 10^{15} cm^{-3}) was generated, and the interaction of this highly conducting plasma with a transverse quasi step-like magnetic barrier (2.4 KG) was studied. Time-resolved photographic observation and measurements by the standard techniques of spectroscopy, laser interferometry and a double probe were performed. The results obtained indicated that a collisionless electrostatic shock was excited in front of the barrier as a result of the drastic compression. The initially cold plasma was substantially thermalized by the shock, and the electron density increased by a factor of ~4. The estimated shock thickness was 2–3 cm. When $\rho V^2 \geq (B^2/2\mu_0)$, the plasma penetrated the barrier in the form of a sheet oriented in the field direction as reported by Scott. Under certain experimental conditions the penetration was in the form of discrete "blobs." For this nonuniform shock, a simple dynamic model was given, and the shock path was numerically determined. Qualitatively, the theoretical model predicts the experimental results satisfactorily. (Diss. Abstr. Int., B)

1735 CURRENT SHEET MICROSTRUCTURE IN AN INVERSE Z-PINCH. Woodruff, T. J. Nashville; Vanderbilt Univ. (1973). 150p. University Microfilms Order No. 74-1362.

Thesis (Ph.D.).

A shock-wave current sheet system propagating into an initially cold, neutral gas was studied. The experiment was performed in an inverse z-pinch device which was operated both with and without an axial magnetic field (B_{z0}) of 1000 gauss imposed transverse to the flow. Electric and magnetic field probes were used to detect all the nonnegligible components of the electric and magnetic fields. Profiles of the various electric and magnetic fields were constructed using the data from the probes, and profiles of the plasma parameters such as current density, electron temperature, electron number density, force density, and ion velocity were constructed from the data profiles. These profiles showed the shock wave-current sheet structure to be quite complex with the shock running well within the current sheet. It was determined that the electrons carry the current, are acted upon by the radial force density, and accelerate the ions via a radial charge separation electric field. Ohmic heating was found to be the principal heating mechanism within the current sheet. With $B_{z0} = 0$, the radial force density and radial electric field are directed outward for the full length of the flow. Thus, the current sheet and shock are accelerated outward at all times. With $B_{z0} = 1$ kG, however, the radial force density and radial electric field, while directed outward at small radii, reverse direction and are directed inward at larger radii. Thus the shock moves forward within the current sheet after the axial magnetic field is imposed. The reversal of the radial force density is brought about by the production of a diamagnetic current density due to the flow through the imposed magnetic field. This diamagnetic current density also accounts for the observed axial magnetic field structure which is that the field increases as the current sheet approaches and decreases rapidly as the current sheet passes. (Diss. Abstr. Int., B)

1736 DETECTION OF CHERENKOV RADIATION EXCITED BY A LOW-INTENSITY ELECTRON BEAM IN MAGNETOPLASMA. Fukao, M. (Kyoto Univ.). Plasma Phys.; 16: No. 4, 351-364 (Apr 1974).

Radiofrequency emission was detected in low-intensity electron-beam experiments in magnetoplasma and identified with Cherenkov radiation since its behavior was in good agreement with the theory of the Cherenkov mode. In order to facilitate the experiments and to avoid undesirable perturbations, a stable low pressure ECRH-type plasma source, a tenuous electron beam of energies from 5 to 30 keV, and lock-in instrumentation of high sensitivity for rf-field measurement were used. The spectrum and polarization of the radiation, as well as the dependence of its intensity upon the plasma and beam parameters, were investigated. From the observed relation between the radiation intensity and the beam current, it was concluded that the radiation tended to become coherent above a certain threshold value of the beam current. The threshold value and its dependence on beam energy were in good agreement with the stability criterion for a thin beam–plasma interaction. (auth)

Kinetics (Theoretical)

1737 LIGHT SCATTERING IN COLLISIONAL PLASMAS. Leonard, E. M. Ann Arbor, MI; Univ. of Michigan (1973). 77p. University Microfilms Order No. 74-3669.

Thesis (Ph.D.).

The scattering of electromagnetic radiation by a fully ionized, collision dominated plasma in a magnetic field is investigated using a stochastic approach. The stochastic equations for the density fluctuation operators are modified to include like particle collisions through a BGK collision model. The equations of this model are constructed to conserve particle number, energy and momentum. Explicit numerical results are obtained in the absence of magnetic fields and compared to experiments and other theories. The analytical results are assumed valid for plasmas which can be characterized by Maxwellian velocity distributions for electrons and ions at the same or different temperatures. (Diss. Abstr. Int., B)

1738 INVESTIGATION OF THE INTERACTION OF LASER RADIATION WITH PLASMA ELECTRONS. Seely, J. F. Knoxville, TN; Univ. of Tennessee (1973). 91p. University Microfilms Order No. 74-3866.

Thesis (Ph.D.).

The interaction of laser radiation with plasma electrons is investigated from a quantum mechanical viewpoint. The electromagnetic field of the laser beam is treated as a classical plane wave, and the plasma electrons are treated quantum mechanically. The absorption of laser radiation by multiphoton inverse Bremsstrahlung is considered. A kinetic equation is derived and the change in kinetic energy of the electrons is calculated. Effective collision frequencies are found for the two cases of weak field and strong field and are compared to the classical results. The reflection coefficient of intense laser radiation incident on a plasma is found to approach unity for high field intensities when only inverse Bremsstrahlung absorption is considered. Finally, the solution to the Schroedinger equation for a particle in an electromagnetic wave and a parallel magnetic field is obtained. The production of positron–electron pairs in a laser beam is considered. Using the Volkov solutions to the Dirac equation, an expression for the cross section for pair production induced by the absorption of a gamma ray is derived. It is shown that electrons behave like spinless particles in an intense laser beam. Using solutions to the Klein–Gordon equation, expressions for the cross sections for pair production induced by the absorption of a gamma ray and by scattering from a nucleus are derived. (Diss. Abstr. Int., B)

1739 NONLINEAR SATURATION OF CONVECTIVELY UNSTABLE BEAM–PLASMA INTERACTION. Boyd, D. A. Hoboken, NJ; Stevens Inst. of Tech. (1973). 107p. University Microfilms Order No. 74-862.

Thesis (Ph.D.).

The convectively unstable wave which occurs above the electron cyclotron frequency in beam–plasma systems in a magnetic field, was studied experimentally. In the linear regime, good experimental agreement was obtained with a theory that includes finite plasma electron temperature and finite perpendicular wavenumber in the interaction. A single convectively growing wave saturates by trapping the electron beam particles. Detailed measurements on the harmonic spectrum show that the spatial beam bunching which occurs in trapping is well described by existing trapping theory. The nonlinear wavelength change predicted by the theory was observed. Measurements were made on the velocity distribution function of the electron beam. Time averaged measurements, made at different axial positions show the trapped particles oscillating in the wave potential wells. Distributions obtained as a function of the phase of the wave enable phase space plots of the beam distribution to be made. They show well developed trapped particle vortices in phase space and that a large fraction of the beam particles become untrapped after saturation. A novel system was developed to measure the distribution of velocities perpendicular to the magnetic field. Measurements with this system show that the beam particles acquire very little perpendicular velocity in the interaction and that they continue to lose energy while the wave is damping. (Diss. Abstr. Int., B)

1740 COMPOSITE PARTICLES IN MANY-BODY SYSTEMS METHOD OF STOLT AND BRITTIN. Brittin, W. E. (Univ. of Colorado, Boulder). Lect. Theor. Phys.; 14B: 55-96(1973).

A system of protons and electrons interacting through Coulomb forces is considered. A Hilbert space theory is developed for this many-body system. The space contains functions belonging to all symmetry classes and not only to those which represent physical states. The physical states are represented by functions which are completely antisymmetric with respect to permutations of proton (electron) coordinates. The detailed theory is presented. (MOW)

1741 FORMULATION OF THE MANY-BODY PROBLEM FOR COMPOSITE PARTICLES. Girardeau, M. D. (Univ. of Oregon, Eugene). Lect. Theor. Phys.; 14B: 147-249(1973).

It is shown how a second-quantization formalism for many-atom systems in which unbounded nuclei, unbound electrons, and bound atoms are represented by elementary particle field operators and can be constructed by a sequence of changes of representation, starting with the usual Schroedinger representation in terms of the dynamical variables of all nuclei and electrons. (MOW)

1742 ELECTRON COLLISION FREQUENCY OBSERVATIONS IN H_2, D_2, N_2O, CO_2 AND ARGON AT PRESSURES OF 0.4 TO 2 TORR. Freeman, R. H.; Roberts, J. A. (North Texas State Univ., Denton). Plasma Phys.; 16: No. 4, 377-383(Apr 1974).

An investigation was made of the nature of the collision frequency of the electrons in H_2, D_2, N_2O, CO_2 and Argon plasmas at different pressures and ion densities. The investigation demonstrated that collision cross sections for the particles in the plasmas could be probed effectively using a resonant microwave cavity technique only when suitable allowances were made for resonant modes of the plasma interacting with the cavity. Curves giving the profiles of collision frequency ν_m vs ion density $\langle n \rangle$ for various pressures of these gases were presented. Ion densities and collision frequencies were obtained using the perturbation equations of Slater (Slater, J. C. (1946) Rev. Mod. Phys., 18, 482). Resonance phenomena were observed in which plasma modes couple strongly with the microwave cavity. Under these conditions of strong coupling of the plasma modes with the cavity modes, the perturbation equation which predicts the collision frequency for momentum transfer predicts anomalous results for ν_m. These resonance effects were assumed to be due to some of the wave phenomena which have been predicted in a dc discharge plasma. (auth)

1743 PRESSURE BALANCE OF A STATIONARY MAGNETIZED PLASMA. Iehnert, B. (Royal Inst. of Tech., Stockholm). Plasma Phys.; 16: No. 4, 341-350(Apr 1974).

The pressure gradient dp/dr of a steady-state magnetized thermonuclear plasma column is determined by the Nernst effect, the emitted neutron flux, the ionization rate in regions containing neutral gas, externally imposed plasma sources and sinks, and by the pinch effect of an axial current. When the temperature gradient $dT/dr < 0$, only the neutron flux and the imposed sinks tend to make dp/dr positive, whereas all other mechanisms just mentioned have an opposite effect. The analysis further yields the following results: (1) the Nernst effect on dp/dr can be outbalanced by very small radial plasma velocities; (2) in regions with moderately large $-dT/dr > 0$ the neutron flux effect outbalances the negative contribution to dp/dr from the Nernst effect. In regions with large $-dT/dr$ such as in the outer parts of the column, however, the Nernst effect becomes more important than the neutron flux effect; (3) even in presence of very small traces of neutral gas, the ionization rate and its associated radial motions yield negative contributions to dp/dr being far more important than the Nernst effect; and (4) it should be possible to control the pressure gradient by means of external matter injection and extraction. Some possibilities are offered by pellet injection, neutral particle beams, and by plasma injection and extraction at the ends of open bottles or by means of inserted magnetically shielded obstacles and supports. (auth)

1744 ROLE OF NONLINEAR EFFECTS ON INTERACTION OF RELATIVISTIC BEAMS WITH A PLASMA. Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 173-180(1973). (In Russian).

Nonlinear plasma theory is used to determine effective relaxation times of relativistic electron beams for various values of particle energy dispersion, electron temperature, ion temperature, and plasma density. It is shown that the effectiveness of the interaction of relativistic beams may be substantially less than that of nonrelativistic beams; in particular, in correspondence with observations the relativistic beams may turn out to be quite stable. On the other hand, the necessary conditions are specified under which the relativistic beams would be relaxed sufficiently fast in the plasma. (auth)

1745 BREMSSTRAHLUNG RADIATION OF A RELATIVISTIC PLASMA. Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR; 66: 191-204(1973). (In Russian).

The theory of spontaneous and induced bremsstrahlung radiation is developed for relativistic particles in a plasma. It is shown that this radiation may be interpreted in the language of the appearance of virtual longitudinal and radial waves on collision of particles and their subsequent conversion into electromagnetic waves of high frequency on electrons and ions of the plasma. The effects of the conversion in this case are described by the same matrix elements which were obtained earlier in the nonlinear plasma theory. Known compensatory effects in this conversion may be manifested in the bremsstrahlung radiation intensity. Estimates are also made on increments of bremsstrahlung instability because of induced bremsstrahlung radiation. (auth)

1746 SCALING LAWS FOR HIGH-DENSITY PLASMAS. Muehe, C.E. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). J. Appl. Phys. 45: No. 1, 82-84 (Jan 1974).

The classical "similarity laws" for electrical discharges in gases are rederived and shown to apply only to cases where the charge density is low enough so that the only important collisions are with gas molecules and there is no appreciable gas heating. If the charge density is high enough to be well above the transition from free to ambipolar diffusion, then the distribution functions of all the particles, and particularly the charge density, can be scaled by dividing by the neutral gas density N_0 at some point in the discharge. The usual similarity laws scale the charge density by dividing by the square of the neutral gas density. These new high-density plasma scaling laws are shown to apply to the experimental results of the current limit at which striations will appear in argon discharges as reported by two investigators. Here the pressure-current product was plotted as a function of the pressure-radius product and found to form one curve over a 4 : 1 range of tube radii. We believe that these high-density scaling laws apply to a large group of plasma phenomena. Limitations of the new scaling laws are pointed out in connection with the spontaneous emission of excited states, three-body collision, magnetic fields produced by the currents in a discharge, the rf shielding effect in a discharge of sufficiently high conductivity, and gravitational effects. (auth)

Production

1747 EFFECT OF MAGNETIC FIELD UPON PLASMAS PRODUCED BY LASER-INDUCED GAS BREAKDOWN. Loter, N.G.; Raff, G.J.; Cohn, D.R.; Halverson, W. (Francis Bitter National Magnet Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). J. Appl. Phys. 45: No. 1, 97-102 (Jan 1974).

The effect of a magnetic field upon the properties of a plasma created by CO_2 laser-induced gas breakdown in helium has been investigated. Spatially and temporally resolved temperatures in the 7-20-eV range were observed using the spectral-line ratio technique, in particular the He II 468.6-nm line-to-continuum ratio. The continuum measurements were also employed to obtain relative values of electron density. The temporal dependences of electron density and temperature indicate that energy is lost from the plasma by an adiabaticlike expansion. The presence of the magnetic field significantly decreases both the energy and density loss rates. (auth)

Stability

1748 FINITE-β STABILIZATION OF FLUTE-LIKE MICROINSTABILITIES. El-Nadi, A.; Emmert, G. A. (Univ. of Wisconsin, Madison). Plasma Phys.; 16: No. 4, 365-375(Apr 1974).

The stability of a finite-β plasma with density and temperature gradients located in a cylindrically symmetric azimuthal magnetic field was investigated using the Vlasov-Maxwell set of equations. The frequency was assumed to be low but finite gyroradius and wave-guiding center resonance effects were retained. It was found that β can both stabilize and destabilize the fast flute mode depending on the gradients, but had no effect on the temperature gradient mode. The interchange mode was essentially unaffected by β. This latter result was in agreement with results from fluid models, as might be expected. (auth)

1749 EFFECT OF FINITE LARMOR RADIUS ON THERMAL INSTABILITY OF A PLASMA. Sharma, R. C. (Himachal Pradesh Univ., Simla, India). Nuovo Cim.; 20B: No. 2, 303-308(11 Apr 1974).

The thermal instability of a plasma in the presence of a transverse magnetic field is studied to include the effects of finiteness of the ion Larmor radius. The finite Larmor radius is found to have a stabilizing influence for the stationary convection. Also, for the case of over-stability, the conditions for its nonexistence are investigated. (auth)

1750 NONSTATIONARY PARAMETRIC TURBULENCE OF A PLASMA. Andreev, N. E.; Pustovalov, V. V.; Silin, V. P.; Tikhonchuk, V. T. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 18: No. 10, 366-369(20 Nov 1973).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 18: No. 10, 624-629(20 Nov 1973).

The evolution of plasma turbulence initiated by parametric instability (by the decay of the pump wave into two plasmons) and saturated by induced scattering of the plasmons from the ions was studied. It is shown that parametric turbulence develops in a dense plasma during a nanosecond pulse from a powerful neodymium laser, and is essentially nonstationary as a result of the oscillations of the noise about the turbulence level. (auth)

Thermonuclear Engineering and Equipment

Refer also to abstract 237.

1751 (UCRL-75252) HELIUM DOPING OF NIOBIUM WITH TRITIUM. Hickman, R. G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Feb 1974. 14p. (CONF-740402-6). Dep. NTIS $4.00.

From topical meeting on technology of controlled nuclear fusion; San Diego, California, USA (16 Apr 1974).

A technique was developed by which niobium specimens can be uniformly doped with helium. This technique uses the radioactive decay of tritium to produce ^3He within the metal lattice. These specimens can be conveniently used in other experiments because they can be decontaminated with respect to tritium. Decontamination requires equilibrium of the specimens with a chemical tritium getter, both of which are submerged in molten lithium. Costs of this multistep procedure are believed to compare very favorably with implantation techniques or exposures in nuclear reactors. (auth)

1752 (UCRL-75596) CONCEPTUAL DESIGN CONSIDERATIONS FOR D-T MIRROR REACTORS WITH AND WITHOUT A FISSION BLANKET. Moir, R. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1974. 28p. (CONF-740402-7). Dep. NTIS $4.50.

From topical meeting on technology of controlled nuclear fusion; San Diego, California, USA (16 Apr 1974).

A modified Lawson criterion on the values of the product $n\tau$ required for a mirror fusion reactor with direct energy conversion to achieve zero net electrical power (scientific feasibility) and to produce sufficient excess net electrical power to possibly be of economic interest ("economic" feasibility) is derived. The $n\tau$ product, where n is the ion density and τ the mean ion containment time, is strongly dependent on the mean ion energy. For one particular model for the reactor component efficiencies and using recent Fokker-Planck calculations of "classical" collisional losses we find that net power (breakeven) is achieved at 70 keV injection energy (80 keV mean ion energy) and an $n\tau = 2 \times 10^{13}$ cm^{-3} sec and "economic" power (25% plant efficiency) is indicated at 200 keV injection energy and an $n\tau = 1 \times 10^{14}$ cm^{-3} sec. A cost analysis gave a minimum plant cost at 200 keV injection energy. The simple one-stage direct converter, due to its low capital cost, gave the lowest plant cost in spite of its efficiency being only 48%. Another reactor model discussed was a mirror fission-fusion hybrid. For the particular parameters chosen we find breakeven power at 30 keV injection energy and an $n\tau$ of 5.5×10^{12} cm^{-3} sec. "Economic" power was obtained at 55 keV injection and an $n\tau$ of 1.3×10^{13} cm^{-3} sec. At 130-keV injection energy economic power (30%

plant efficiency) is obtained with the loss rate 2.5 times classical. (auth)

1753 ELECTRON-BEAM INITIATED RELEASE OF THERMONUCLEAR ENERGY. Bowden, C. M.; Hagood, J. W.; Norman, R. L.; Shelton, J. (Army Missile Command, Redstone Arsenal, AL). Nucl. Instrum. Methods; 116: No. 1, 201-202(1974).

A recently developed oxide-metal composite, used as a field-effect emitter, can be used to establish the energy-deposition requirements for controlled release of thermonuclear energy. (auth)

1754 ENGINEERING FEASIBILITY OF A FUSION REACTOR. Boom, R. W.; Kulcinski, G.; Maynard, C. W.; Vogelsang, W. F. (Univ. of Wisconsin, Madison). Proc. Amer. Power Conf.; 35: 407-420(1973).

From the American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The feasibility of using a large Tokamak device in a fusion power system is examined. Four main problems discussed are: (1) those aspects of the plasma that are of particular interest and importance in a power reactor assuming that confinement of the plasma is assured from the results of the experiments currently being planned; (2) the materials problems anticipated are most severe in the first wall where the radiation and thermal environment is possibly the worst ever seriously envisioned for a real material; (3) induced radioactivity in the reactor components; (4) the largest contribution to the costs of a fusion plant is expected to be that of the very large superconducting magnets needed to produce the magnetic fields. The distinctive features of these units are discussed. (MCW)

Wave Phenomena

1755 WAVE DIFFRACTION ON A RANDOM PHASE SCREEN IN A MAGNETOACTIVE PLASMA. Tamoikin, V. V.; Zamek, I. G. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 17: No. 1, 31-37(1974). (In Russian).

The propagation of radiation through a random screen in a magnetoactive plasma is considered. The correlation functions of the complex field of ordinary and extraordinary waves as well as their mutual correlation are calculated. The problem of depolarization of fluctuating radiation propagating through a homogeneous magnetoactive plasma is investigated. General expressions are derived for Stokes parameters and the depolarization factor. (auth)

1756 INSTABILITY OF LONGITUDINAL CYCLOTRON WAVES IN RAREFIED PLASMA WITH DISPERSION OF ELECTRON VELOCITIES. Zlotnik, E. Ya. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 17: No. 1, 17-30(1974). (In Russian).

The instability of plasma waves at the electron gyrofrequency harmonics in a rarefied nonequilibrium plasma with longitudinal and transverse electron pulse dispersion is considered. Using Nyquist's method, it is shown that over a wide interval of angles between the wave vector and the magnetic field where the relativistic mass dependence may be neglected, the plasma is stable with respect to longitudinal cyclotron waves. Over the narrow interval of angles near the transverse propagation where the allowance for electron relativism becomes necessary, the criterion of plasma wave instability is found. The increments of kinetic and hydrodynamic instabilities of cyclotron waves are obtained. Their dependence on the plasma parameters is examined. (auth)

1757 PROPERTIES OF WAVES GUIDED BY A PLASMA COLUMN AS DETERMINED BY TIME-OF-FLIGHT MEASUREMENTS. Iandt, D. L.; Hsuan, H. C. S.; Lonngren, K. E. (Univ. of Iowa, Iowa City). Plasma Phys.; 16: No. 4, 407-412(Apr 1974).

Experiments designed to investigate several properties of waves which are guided by a plasma column using time-of-flight techniques were described. The properties described were: (a) dispersion of a sine-wave burst; (b) response to a short voltage impulse (delta function); (c) reflection properties; and (d) measurement of the electron drift velocity in the tube. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 133, 405, 558, 559, and 1233.

1758 (UCD-472-119, pp 27-33) MEASUREMENT OF 20-, 35-, AND 45-MeV PROTON DEPTH DOSE FOR IRRADIATION OF BEAGLES BY Si(Li) AND THERMOLUMINESCENT DOSIMETERS. Momeni, M. H.; Cahill, T. A. Jun 1972.

In annual report, fiscal year 1972.

A Si(Li) solid state detector, TLD-100, CsI, and fast x-ray film were used to measure proton fluence, energy distribution, and depth dose in a cubical lucite phantom beagle exposed to beams of 20-, 35-, and 45-MeV protons. The ranges in lucite were 7, 10, and 18 mm and the respective Bragg peaks were at depths of 5.5, 9, and 16 mm, respectively, for 20-, 35-, and 45-MeV protons. The data indicate that TLD-100 is relatively energy independent over this energy range. (auth)

1759 ABSOLUTE MEASUREMENT OF LOW ENERGY ELECTRON DEPOSITION PROFILE IN SEMI-INFINITE GEOMETRIES. Lockwood, G. J.; Miller, G. H.; Halbleib, J. A. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 326-330(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Two different techniques have been used to measure absolute electron energy deposition profiles in semi-infinite geometries. The first, employing an ionization chamber, was used to measure energy deposition by normally incident electrons at incident energies of 1.0, 0.5, and 0.3 MeV in aluminum, and 1.0 MeV in tantalum. The second method is unique in that it represents the first calorimetric measurement of energy deposition from a monoenergetic dc source. Results are given for normally incident electrons at an incident energy of 1.0 MeV in aluminum, and at incident energies of 1.0 and 0.5 MeV in tantalum. The latter method circumvents some of the difficulties inherent in the ion chamber technique and provides more precise results. (auth)

1760 ANALYTICAL PREDICTION OF PHOTO-COMPTON EMISSION CURRENTS. Dellin, T. A. (Sandia Labs., Livermore, CA); MacCallum, C. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 91-96(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

An analytical procedure for describing vacuum photoemission from one-dimensional materials more than one electron range thick has been developed. The magnitude, angular and energy distributions are expressed in terms of bulk photo-Compton current information by algebraic formulae. A semi-empirical equation for the low energy component (<100 eV) is also presented. Comparison with experimental data is good, comparable to that obtained using more sophisticated Monte Carlo codes, except in extreme cases. (auth)

1761 NUMERICAL SOLUTION OF THE SPENCER–LEWIS EQUATION FOR KILOVOLT ELECTRON TRANSPORT IN PLANE SLABS. Garth, J. C. (Air Force Cambridge Research Labs., Bedford, MA); O'Brien, J. V. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 82-90(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

A computer program BOLT for the numerical solution of the Spencer–Lewis equation for kilovolt electron transport in finite slabs is described. The method of solution used is a discrete ordinates method utilizing Gauss-quadrature angles equivalent to a 20th order Legendre polynomial expansion of the electron flux distribution function. The ultimate goal of the program is to compute x-ray photoelectron emission from thin targets and energy and charge deposition profiles near solid-vacuum boundaries and at interfaces between materials of differing atomic number. Results are presented for a uniformly distributed monoenergetic electron source function, anisotropic in angle with form $(1 + \beta \cos \theta)$. The values for the charge and energy flow and deposition profiles agree within a few percent with analytic solutions characteristic of an infinite medium and with Monte Carlo transport calculations using simulated electron trajectories. The equilibrium value for the net flow or "Compton current" for 30 kilovolt electrons is found to be about 7 percent higher than the analytic value while all other quantities are believed to be accurate to within 2 percent. The principal source of error appears to be in the evaluation of the collision integral involving the exceedingly narrow deflections characteristic of kilovolt electron scattering. The discretization error due to finite grid sizes in the discrete ordinates scheme used was found to be very small. (auth)

1762 EXTRAPOLATION NUMBER IN THE M TARGETS-ONE HIT MODEL. Abillon, E. (CEN de Saclay, Gif-sur-Yvette, France). Math. Biosci.; 19: No. 3-4, 191-200(Apr 1974).

In the "m targets–one hit" model without recovery, the extrapolation number is equal to the number of targets m. Here what the extrapolation number becomes when the recovery of hit targets is included in this model is considered. It is shown that it is then a function of two parameters: the number of targets m and the ratio of the probability of recovery to the probability of hit: α/a. An algebraic example for $m = 2$ and a numerical illustration for the values $3 \leq m \leq 10$ are given. Adding a single target component in this model does not modify the value of the extrapolation number. (auth)

1763 PRACTICAL ASPECTS OF NEUTRON DOSIMETRY IN BIOLOGY AND MEDICINE. Broerse, J. J. (Instituut TNO Voor Werkluegkundige Constructies, Delft, Netherlands). J. Belge Radiol.; 56: No. 5, 431-434(1973).

A number of practical aspects of neutron dosimetry in biology and medicine are discussed; in particular: the variations of absorbed dose at interfaces of materials of different atomic composition, experimental techniques employed to determine the kerma in soft tissue, measurements of the distribution of absorbed dose due to neutrons and gamma rays in tissue equivalent phantoms. (auth)

1764 ENERGY LOSSES OF IONS INTERACTING WITH SOLIDS. Komarov, F. F.; Kumakhov, M. A. (Belorussian State Univ., Minsk). Izv. Akad. Nauk SSSR, Ser. Fiz.; 37: No. 12, 2578-2584(Dec 1973). (In Russian).

Analytical expressions for the Slater atomic model are obtained for the calculation of the electron density in flat and axial channels of crystals. These expressions are used in the determination of the energy loss of light ions. The energy loss of heavy ions is examined in the modified Firsov theory taking into consideration the shell effect of the structure of the colliding particles. (tr-auth)

1765 ENERGY LOSSES OF IONS SCATTERED BY THE SURFACE OF MONOCRYSTALS. Machenko, S. D.; Nizhnaya, S. L.; Parilis, E. S.; Turaev, N. Yu. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 37: No. 12, 2594-2595(Dec 1973). (In Russian).

A comparison is made of the energy spectra of Ar ions scattered by the surface of Cu monocrystals. The spectra are calculated by three models: two-atomic, four-atomic and models with infinite chain. (tr-auth)

1766 DETERMINATION OF THE PENETRATION DEPTH OF SLOW ELECTRONS $I_{00}(E_p)$. Azov, K. K.; Denisov, V. P.; Zyryanov, G. K. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 37: No. 12, 2617-2621(Dec 1973). (In Russian).

On the basis of the introduction of the concept of an electron transmission coefficient and contrast of the diffraction diagram of slow electrons an analysis is made of the relation $I_{00}(E_p)$. The extinction length is determined as 4 Å for Si and 4 to 6 Å for W in the energy interval from 100 to 200 ev. (tr-auth)

1767 INTEGRAL ABSORBED DOSE. Its Interest in Radioprotection. Bercy, A. (Univ., Liege). J. Belge Radiol.; 56: No. 5, 451-455(1973). (In French).

The author shows by concrete examples the easy way of calculating the integral absorbed dose in radiotherapy, radiography and also in curietherapy. The knowledge of this integral absorbed dose enables to choose the less dangerous for the patient among two irradiation techniques. The integral dose absorbed by a radiologist, by a technician handling radiography or radiocobalt apparatus is also calculated. (auth)

1768 CALCULATION OF FLUORESCENCE-X RADIATION PRODUCTION. Casnati, E.; Paganini Fioratti, M.; Ricci Piermattei, S. (CNEN, Rome). Com. Naz. Energ. Nucl., Notiz.; 16: No. 3, 113-130(1972). (In Italian).

A calculation method is described for evaluating the exposure rate due to the fluorescence x-rays excited in targets of different elements by bremsstrahlung radiation produced by commercial x-ray apparatus. The contribution of Compton and Rayleigh radiation produced by scattering of the primary beam inside the target is also evaluated. The influence on the fluorescence x-rays production of the following parameters: atomic number of the target, target thickness, voltage applied to x-ray tube, has been analyzed. Such an analysis enables the choice of the best condition for producing almost monochromatic beams with scarce contamination of continuous radiation. (auth)

1769 CONVERGENCE OF THE SCATTERING TRANSPORT PROCESS TO BROWNIAN MOTION. Gorostiza, L. G. Rev. Mex. Fis.; 21: No. 4, 273-276(1972).

It is shown that the convergence in distribution of the multi-dimensional isotropic scattering transport process to Brownian motion, is a consequence of a general invariance principle for a class of random motions. (auth)

1770 DEPENDENCE OF ELECTRONIC STOPPING CROSS SECTION OF ^{42}K ON DIFFERENT TARGET MATERIALS. Whitton, J. L. (Chalk River Nuclear Lab., Ont.). Can. J. Phys.; 52: No. 1, 12-16(1 Jan 1974).

Measurement of the maximum range of 55 keV ^{42}K along the ⟨100⟩ directions of bcc metals and ⟨100⟩ directions of fcc metals shows that the electronic stopping cross section differs by a factor of ~5 between the two channels. This difference is considered due to the different electronic configurations of the lattice atoms and is thus analogous to the oscillations in electronic stopping cross section seen previously for various ions in silicon, gold, and tungsten. (auth)

1771 MAXIMUM PERMISSIBLE HIGH-ENERGY NEUTRON FLUXES. Dmitrievskii, I. M.; Potemkin, E. L.; Frolov, V. V. (Moscow Engineering-Physics Inst.). pp 493-494 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Methods for determining the spatial distributions of tissue doses and working out maximum permissible particle fluxes on the basis of those distributions are described. (auth)

1772 ENERGY TRANSFER FROM CHARGED PARTICLES. Boag, J. W. (Inst. of Cancer Research, Sutton, Eng.). pp 9-14 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The theoretical aspects of the problem are discussed drawing freely from the work of Fance and of Platzman and keeping the nature of the medium in the forefront of the discussion. (MHR)

1773 ROLE OF RADIATION-PRODUCED INTERMEDIATES IN UTILIZATION OF ENERGY. Magee, J. L.; Mozumder, A. (Univ. of Notre Dame, IN). pp 15-24 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The response of matter to the deposit of energy by high velocity charged particles is considered. The brief discussion is limited to low LET radiation and molecular liquids such as water. The energy deposition in and radiolysis of water are discussed briefly. (MHR)

1774 ENERGY DEPOSITION BY FAST ELECTRONS IN SMALL REGIONS OF MATTER. Harder, D. (Univ., Wuerzburg, Ger.). pp 25-38 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Experimental and theoretical examples are given, mainly from recent publications, in order to serve as a key to the field of electron energy dissipation in small regions. The Monte Carlo method is acknowledged as a powerful instrument in calculating the complex overlap of different cross sections that are responsible for the pattern of energy deposition. (MHR)

1775 CRITICAL LEVELS OF ENERGY DEGRADATION. Kellerer, A. (Columbia Univ., New York). pp 53-60 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

Radiation quantities, as for example absorbed dose, and microdosimetric functions for regions of the order of 1μ are meaningful without specification of the critical steps of energy degradation. This is not true for microdosimetric quantities related to regions with linear dimensions near or below 100 Å; the usual techniques of ionization collection are not applicable in this case and measurements have to be based on the collection of positive ions. (MHR)

1776 SPECTRAL DISTRIBUTION OF IONIZATION GLOW OF AIR EXCITED BY RELATIVISTIC ELECTRONS. Volovik, V.D.; Petrenko, V.V.; Popov, G.F.; Fursov, G.L. Opt. Spectrosc. (USSR) 35: No. 3, 331-332 (Sept 1973).

The emission spectrum of ionized glow of air was measured in the region 380–700 nm using a 30 Mev electron beam for excitation. The process leading to ionization and excitation of the gases is investigated. (AIP)

1777 PENETRATION AND ENERGY DEPOSITION OF ELECTRONS IN THICK TARGETS. Jacob, J.H. (Avco Everett Research Laboratory, Inc., A Subsidiary of Avco Corporation, Everett, Massachusetts 02149). J. Appl. Phys. 45: No. 1, 467-475 (Jan 1974).

The transport and energy deposition of fast electrons in multilayer targets are investigated. For a highly peaked distribution function of electrons impinging on a target, it is necessary to use a high–order diffusion theory to adequately represent the distribution function. To a first approximation the energy loss is neglected in any given layer. The average energy loss per layer is then calculated using the Bethe stopping power and knowledge of the electron multiple scattering. Once the beam penetrates a distance of about one–fifth the transport mean free path, it becomes possible to use the Bethe age diffusion equations provided that the atomic number $\geq$ 13 and the electron energies are below 1 MeV. A combination of the diffusion and high–order diffusion theory is also used to compute the backscattered current and energy. Limitations and regions of validity of the above theories are also discussed. (auth)

1778 STOPPING POWER OF CADMIUM SULFIDE FOR HELIUM IONS. Engel, P.F. (Department of Electrical Engineering, University of Colorado, Boulder, Colorado 80302); Borders, J.A.; Chernow, F. J. Appl. Phys. 45: No. 1, 38-42 (Jan 1974).

A new experimental technique has been used to measure the stopping power of CdS for He ions. This technique consists of measuring the energy spectrum of either He ions backscattered from implanted Bi or of α particles emitted by an implanted radioactive isotope, such as Po^{210}. A thin layer is then etched off the surface of the sample and the energy spectrum is measured again. The stopping power is calculated from these two spectra and the known thickness of the removed layer. These measurements and calculations have been made for energies ranging from 0.963 to 5.3 MeV with accuracies between 12% and 16%. (auth)

1779 THEORY OF THE TRANSPORT OF NONSTATIONARY GAMMA RADIATION. Seleznev, N. A. Sov. J. At. Energy (Engl. Transl.); 34: No. 3, 246–247(Mar 1973).

Translated from At. Energ. (USSR); 34: No. 3, 196(Mar 1973). This is a summary of paper No. 654/7095 with full copy held by TIC.

Transition processes associated with the transport of gamma radiation nonstationary in time are considered. It is shown that scattered and regenerated quanta come to a point of a medium with a delay relative to source quanta, the delay being distributed over time. In the general case the phenomenon of the transport of nonstationary gamma radiation is described by a system of inhomogeneous linear integro–differential equations, each of which corresponds to a definite form of radiation. Some of the equations of the system contain a time argument with delay. The conditions of existence and uniqueness of the solution of the above-mentioned system are considered: these conditions are the ones for a sufficiently complete set of boundary conditions in relation to the space–angle variables and initial conditions on the time argument. An exact solution of the transport problem has not yet been found. Two examples of approximate solutions are given. (RWR)

Radiation Protection Standards

Refer also to abstract 133.

1780 INTERNATIONAL COMMISSION ON RADIATION UNITS AND MEASUREMENTS (ICRU) AND ITS RELATION TO RADIATION RESEARCH. Rossi, H. H. (Columbia Univ., New York). pp 1-8 of Advances in Radiation Research. Physics and Chemistry. Vol. 1. Duplan, J. F. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1973).

From fourth international congress of radiation research; Evian, France (29 Jun 1970). See CONF-700610-P1.

The history, progress, and need for future development in the ICRU are summarized briefly. (MHR)

1781 ESTABLISHMENT OF THE INDUSTRIAL STANDARD ON LUMINOUS WATCHES. Genshiryoku Iinkai Geppo; 18: No. 4, 13-17(Apr 1973). (In Japanese).

Results of deliberation on the establishment of JIS standard for luminous watches and clocks are described; which was carried out by an ad hoc committee upon the inquiry by MITI. The purpose

is to set the standard on making luminous timepieces to minimize radiation exposure of general people. Consequence of the exposure concerns the whole range of users, watch stores, fire fighters, transporters, to final disposal. In the Appendix is given evaluation of the radiation exposure in watch circulation, due to ^{3}H and ^{147}Pm used in luminous paint. (JA)

Radiation Source Calibration and Standardization

1782 (FDA-74-8022) PROGRESS IN RADIATION PROTECTION. (Bureau of Radiological Health, Rockville, Md. (USA)). 1973. 11p.

The development and enforcement of radiation protection standards in the USA during 1973 are reviewed. Topics discussed include the development and enforcement of electronic product performance standards to insure the radiation protection of users; proposed performance standards for cabinet x-ray machines for airline luggage inspection; proposed safety standards for laser products; the implementation of safety standards for color TV sets and microwave ovens; proposed safety standards for ultrasound equipment used to treat muscle and joint disabilities; and preparations for enforcement of the safety standards for diagnostic x-ray equipment applicable to components manufactured after August 1, 1974. (CH)

1783 PROGRESS IN THE ESTABLISHMENT OF NEUTRON STANDARDS AT THE NATIONAL PHYSICAL LABORATORY. Axton, E. J.; Hunt, J. B.; Robertson, J. C.; Ryves, T. B. (National Physical Lab., Teddington, Eng.). pp 431-439 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Facilities are provided at the National Physical Laboratory to establish neutron flux density standards at a number of neutron energies from thermal to 19 MeV. A 3 MeV Van de Graaff and a 150 keV Sames positive ion accelerator are used in conjunction with analyzing magnets to direct beams of accelerated charged particles along a number of flight tubes to irradiate neutron-producing targets in a number of neutron production and measurements facilities. Standards already available in the thermal, intermediate and fast neutron energy ranges are described together with plans for their extension and for calibration in the 1 eV to 1 keV energy range. A kerma standard for neutron therapy is also envisaged. (auth)

1784 NEUTRON SOURCE AND FLUX STANDARDIZATION AT TROMBAY: RECENT DEVELOPMENT OF TECHNIQUES. Shahani, M. G.; Sharma, D.; Kamboj, B. K. (Bhabha Atomic Research Centre, Trombay, India). pp 441-452 of Neutron Monitoring for Radiation Protection Purposes. Volume II. Vienna; International Atomic Energy Agency (1973).

From symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The thermal-neutron flux density standard established at the Bhabha Atomic Research Centre has been absolutely calibrated in terms of ^{55}Mn neutron capture cross-section by $4\pi\ \beta-\gamma$ coincidence counting of thin manganese-nickel foils. The conventional flux density below cadmium cut-off energy is estimated to be 6497 ± 1.1% $n \cdot cm^{-2}\ s^{-1}$, which is in good agreement with an earlier measurement with thin gold foils as well as with the value obtained from an analysis of the results of the flux intercomparison arranged by the International Bureau of Weights and Measures. The slowing down spectrum in the flux standard was measured by the activation of resonance detectors and shown to obey the 1/E law. An improved manganese bath pumping technique which has been used to establish a 500-mCi AmBe (α,n) neutron source standard is described. The emission rate of the source is estimated to be 9.95×10^{6} ± 0.7%. (auth)

Shielding Calculations and Experiments

Refer also to abstract 1015.

1785 (AD-769711) IN-AND-DOWN SCATTERED RADIATION IN A SIMPLE CONCRETE STRUCTURE. Final Report. Schmoke, M. A. (Ballistic Research Labs., Aberdeen Proving Ground, Md. (USA)). Sep 1973. 151p. (BRL-1665). NTIS $4.75.

Measurements were made of the radiation scattered in the aboveground wall and down to a detector in a basement of a simple concrete structure in a fallout radiation field simulated by a circulating point source of cobalt-60. The structure was so constructed that parameters such as aboveground wall height, wall thickness, basement ceiling thickness and aboveground roof thickness, could be varied. The results of these measurements were converted to reduction factors (ratio of the measured exposure rate within the structure to the free-field exposure rate at a 3 foot height above an infinite field) and compared with results predicted by the Engineering Method and the Engineering Method as revised by Eisenhauer. Where applicable, the results were also converted to basement ceiling attenuation factors (ratio of the exposure rate at a basement position with ceiling emplaced to the exposure rate at the same position without the basement ceiling) and compared with the empirically derived Eisenhauer formulation, for (B_c) (X_c) omega, the basement ceiling attenuation factor. (GRA)

1786 (ORNL-tr-2807) ANGLE-DEPENDENT GAMMA ENERGY FLUX IN A CONCRETE SHIELD. Penkuhn, H. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). [nd]. Translated by R. G. Mansfield from 1974 Reactor Meeting of the German Atomic Forum/KTG, Berlin. 4p. Dep. NTIS $3.00.

For scattering angles $\varphi \lesssim 30°$ the angular gamma energy flux in a plane concrete shield is approximated by a power of $\cos\varphi$; its exponent increases approximately linearly with penetration. For large values of φ other approximations are described. (auth)

PHYSICS (THEORETICAL)

General

1787 PHASE TRANSITIONS IN OPEN SYSTEMS FAR FROM THERMAL EQUILIBRIUM. Hepp, K. (Eidgenoessische Technische Hochschule, Zurich). Acta Phys. Austr., Suppl.; 11: 475-492(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

Lectures are given on an outline of some rigorous results concerning a class of nontrivial quantum mechanical many-body systems with irreversible behavior far away from thermal equilibrium. The example of the laser and mean fields with linear dissipation are treated. (JFP)

1788 SYSTEM IDENTIFICATION: METHODS AND APPLICATIONS. Kagiwada, H. H. Applied Mathematics and Computation. Reading, MA; Addison-Wesley Publishing Company (1974). 307p. $16.00.

System identification problems, i.e., determining the relationship between the internal structure of a system and the observed output are discussed. The topics cover identification of layered media with with multiple scattering data, identification using noisy scattering measurements, inverse problems in radiative transfer for anisotropic scattering, an inverse problem in neutron transport theory, and system identification by measurement of transient waves. Also treated are steady state wave propagation, probing an inhomogeneous medium with rays, nonlinear filtering of signals, nonlinear interpolating filter for imprecise dynamical equations, determination of time lags, and identification problem of cardiology. (JFP)

1789 REMARK ON THE EXISTENCE OF THE THERMODYNAMIC LIMIT. Vallander, S. S. (Leningrad State Univ.). Teor. Mat. Fiz.; 19: No. 1, 97-101(Apr 1974). (In Russian).

An inexactness in the proof of the existence of the thermodynamic limit for classical systems with stable rapidly decreasing potentials (the Van-Hove theorem) is corrected. (auth)

1790 NONLINEAR WAVES AND THEIR INTERACTION. Zaslavskii, G. M. (Inst. of Physics, Krasnoyarsk, USSR). Usp. Fiz. Nauk; 111: No. 3, 395-426(Nov 1973). (In Russian).

The review is devoted to questions connected with the propagation of strongly nonlinear periodic waves in the presence of different types of exciting factors. These problems can be divided into three groups. In the first questions connected with formal apparatus used are considered. The characteristic properties of nonlinear waves, methods of the perturbation theory, canonical variables, and Hamiltonian formalism are discussed. The second groups of questions considered deals with the propagation of nonlinear waves in the presence of external excitation. Resonance interaction between wave and external force, stochastic instability of nonlinear waves, variation of the adiabatic invariant of nonlinear waves in weakly inhomogeneous medium and in medium with chance inhomogeneity are described. In the third group of processes examined questions connected with weak interaction of strongly nonlinear waves are discussed. Conditions under which the interaction of waves is weak are explained and the interaction of two waves and the resonance interaction of three waves are examined. The study of the ensemble of a large number of nonlinear waves and its description with kinetic equations are considered. Questions connected with the energy-momentum tensors of nonlinear wave equations are also discussed. (tr-auth)

Quantum Field Theories

Refer also to abstracts 1398, 1417, 1488, 1506, 1816, 1819, and 2262.

1791 MODEL NONLOCAL FIELD THEORY WITH SOME CAUSAL PROPERTIES OF A DUAL THEORY. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B71: No. 3, 445-460(1974).

A simple field theory is presented which reproduces the singularity structure associated with acausality of the planar dual loop. The field theory differs fundamentally from a conventional non-local theory in that (in the tree approximation) the elementary length is independent of the order of interaction, and, on renormalisation, can become zero. (auth)

1792 RENORMALIZATION OF YANG-MILLS THEORIES. Tonin, M. (Univ., Padua). Lett. Nuovo Cim.; 9: No. 14, 541-548(6 Apr 1974).

The Lee identities and the dimensional regularization are exploited to carry out in a simple way the renormalization program for Yang-Mills field theories. (LBS)

1793 UNITARITY IN EFIMOV'S THEORY. Kazes, E. (Pennsylvania State Univ., University Park). Lett. Nuovo Cim.; 9: No. 14, 554-556(6 Apr 1974).

It is shown that Efimov's construction of an S matrix for relativistic four-particle interactions is not sufficient to ensure unitarity. In the context of this theory a simple explanation for the difference between generalized unitarity and physical unitarity is given. (LBS)

1794 SPONTANEOUSLY MASSIVE DILATONS. Drummond, I. T. (Univ. of Cambridge, Eng.). Nucl. Phys.; B72: No. 1, 41-60(1974).

It is shown how the dilatons which are present in the tree approximation to a simple model acquire a mass when unitarity corrections are taken into account. The analysis is based on the work of Coleman and Weinberg. The model is simpler and involves only scalar fields. The effective potential can therefore be calculated as a function of all the fields. This gives a particularly clear view of the nature of the infrared divergences. The trace of the energy momentum tensor is calculated explicitly and it is shown that it exhibits effective P.C.D.C. The model is compared and contrasted with one which involves an explicit scale non-invariant mass term. (auth)

1795 INFRARED BEHAVIOR IN A MODEL FOR QUANTUM ELECTRODYNAMICS. Manoukian, E. B. (Univ. of Alberta, Edmonton). Can. J. Phys.; 51: No. 24, 2511-2515(15 Dec 1973).

Previously a particular solution of the Ward–Takahashi identity was set up as a model for quantum electrodynamics. The high energy behavior of the electron and photon propagators was investigated. The purpose is to investigate the asymptotic infrared behavior of the electron propagator near the mass shell in the model-theory. It is shown that, in general, it has a branch point, rather than just a pole at $p^2 = -m^2$, with the "singularity" being different from the known result of Abrikosov and Solov'ev, and coincides with theirs only in the gauge $G = -1$. The electron propagator, however, has rigorously a pole in the Yennie gauge. (auth)

1796 ASYMPTOTIC LOGARITHMIC BEHAVIOR AND THE COMPLEX DIMENSIONALITY PARAMETER. Lukierski, J. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim.; 20A: No. 4, 669-677(21 Apr 1974).

The field operators characterized by the complex dimensionality parameter $\Delta = \delta + i\beta$ are introduced. Physical field operators, which describe scale-invariant QFT approximately, are assumed to have a definite real part δ of the dimensionality parameter and can be represented as a superposition of the operators with different values of the imaginary part β. It is shown that such a formalism leads in a natural way to the introduction of nonvanishing masses and corresponding thresholds. Two-point and three-point Green's functions are further discussed. (auth)

1797 INFRARED SINGULARITIES IN THEORIES WITH SCALAR MASSLESS PARTICLES. Symanzik, K. (DESY, Hamburg). Acta Phys. Austr., Suppl.; 11: 199-240(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

In order to describe infrared singularities in theories with scalar neutral self-coupled massless particles, the theory is first discussed with massless particles alone, a particular case of ϕ^4 theory; then it is shown that these singularities derived in that theory are the same in theories that have in addition massive particles. (JFP)

1798 CONFORMAL INVARIANT EUCLIDEAN QUANTUM FIELD THEORY. Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Austr., Suppl.; 11: 241-315 (1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

A review of conformal covariant quantum field theory with anomalous dimensions is presented. An emphasis is made on the Euclidean formulation of conformal invariance and skeleton perturbation theory. (auth)

1799 FIELD STRUCTURE THROUGH MODEL STUDIES: ASPECTS OF NONRENORMALIZABLE THEORIES. Klauder, J. R.

(Bell Telephone Labs., Inc., Murray Hill, NJ). Acta Phys. Austr., Suppl.; 11: 341-387(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

Qualitative features of quantum theories are examined with the aid of models. Attention is focused on the fact that for sufficiently singular interaction potentials turning off the coupling need not restore the theory to a free theory. This effect is illustrated in a simple, single degree of freedom system. Analysis of the causes leads one to suggest that this effect may arise for covariant nonrenormalizable quantum field theories, and heuristic arguments are developed to support this proposal. For certain soluble noncovariant nonrenormalizable quantum field theories the reality of the effect is verified, and comments are made on its significance, especially for perturbation analyses. (auth)

1800 RENORMALIZED LOCAL QUANTUM FIELD THEORY AND CRITICAL BEHAVIOR. Jegerlehner, F.; Schroer, B. (Freie Univ., Berlin). Acta Phys. Austr., Suppl.; 11: 389-473(1973).

From 12th international conference on nuclear physics: recent developments in mathematical physics; Schladming, Austria (5 Feb 1973). See CONF-730227-.

Lectures are given on critical phenomena using methods of renormalized local quantum field theory. Similarities and differences between relativistic quantum field theory and the statistical mechanics of critical phenomena, algebraization of the dynamical content, derivation of pre-scaling equations, the short and long range limit of the theory, construction of the critical theories of the ferromagnetic type, magnetic field perturbation on the symmetric theory, temperature- and magnetization perturbation on the scale-invariant theory and Kadanoff's scaling laws, and other models and outlook are discussed. (JFP)

1801 GENERALIZED PAULI–VILLARS REGULARIZATION IN PRESENCE OF ZERO MASS PARTICLES. Slavnov, D. A. (Moscow State Univ.). Teor. Mat. Fiz.; 19: No. 1, 3-13(Apr 1974). (In Russian).

Limiting regularization procedure is proposed which makes it possible to remove the ultraviolet as well as infrared divergencies without making any subtractions. (auth)

1802 EXISTENCE OF LIGHT-LIKE CHARGES IN QUANTUM FIELD THEORY. Jegerlehner, F. (Univ., Bern). Helv. Phys. Acta; 46: 824-843(1974).

The existence of light-like charge operators in the framework of general quantum field theory. The light-like charges present an important tool for a mathematically consistent formulation of the connection between local field theory and the generators of broken internal symmetry transformations. It is found that light-like charges exist as unbounded operators for models with an appropriate behavior of the long-range correlations in light-like directions provided the null plane restriction of the current commutator for the good components is defined. (auth)

1803 CREATION OF FERMION PAIRS IN ALTERNATING UNIFORM EXTERNAL FIELD. Perelomov, A. M. (Inst. of Theoretical and Experimental Physics, Moscow). Teor. Mat. Fiz.; 19: No. 1, 83-96(Apr 1974). (In Russian).

Group-theoretical aspects of the problem of creation of fermion pairs in alternating uniform external field are considered. It is shown that the dynamical symmetry group of the problem is the group SU(2N) (N = 2S + 1S being the spin of the particle) and the state of the system arising in the evolution process is the generalized coherent state connected with this group. Probability of the pair production is given by the squared modulus of the matrix element of a certain representation of the group SU(2N). For the spin ½ particles the symmetry group in some cases reduced to the group SU(2) × SU(2). (auth)

1804 APPROXIMATE SOLUTIONS IN THE MODEL $L_{int} = h^2\psi^2\varphi^2$ AND EQUATIONS FOR GREEN'S FUNCTIONS ON TRAJECTORIES. Barbashov, B. M.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 19: No. 1, 47-58(Apr 1974). (In Russian).

By means of introducing auxiliary fields $A_i(x)$ (i = 1,2) the solution of the model $L_{int} = h^2\psi^2\varphi^2$ is reduced to solving the model $L_{int} = -h\psi^2(x)A_1(x) - h\varphi^2(x)A_2(x)$ and subsequent functional averaging over the fields $A_i(x)$. In the framework of the approximation, which makes it possible to take partially into account the vacuum polarization contributions in the model $-h\varphi^2(x)A_2(x)$ corresponding solutions for Green's function and scattering amplitude in the theory $h^2\psi^2\varphi^2$ are considered. (auth)

1805 EQUATIONS FOR THE S MATRIX COEFFICIENT FUNCTIONS IN QUANTUM FIELD THEORY. Ivanov, S. S.; Petrina, D. Ya.; Rebenko, A. L. (Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 19: No. 1, 37-46(Apr 1974). (In Russian).

The resolvent and evolution type equations for the S-matrix coefficient functions and Green's functions are constructed. The algebraic equivalence between the Schwinger equations and coefficient functions equations of resolvent type is proved. (auth)

1806 ELIMINATION OF PRIMITIVE DIVERGENTS FROM FIELD THEORY BY MEANS OF COMPLEX COUPLING CONSTANTS. Nicholson, A. F. Aust. J. Phys.; 26: No. 6, 703-723 (Dec 1973).

LSZ iteration theory is extended to accommodate quantum fields coupled by complex constants, while retaining a positive metric and a Hermitian Hamiltonian. Interpolating and particle (~in, out) fields are linked by an operator U(t) which is non-unitary, so that Haag's theorem may be avoided. It is shown that U(t) may be rendered sufficiently well behaved as $t \to \pm\infty$ to allow development of the iteration series for the t function. For certain combinations of fields the coupling constants and masses can then be chosen so as to eliminate the primitive divergents from the iteration series for any S-matrix element. The theory is illustrated by two models: four spinor plus two scalar fields, and the electromagnetic plus several spinor fields. In the second model not every spinor field corresponds to a stable physical particle, and the LSZ formalism is extended to allow for this. (auth)

Gravitation and General Relativity

1807 (JINR-P2-7708) QUANTUM STATISTICS OF MASSLESS SCALAR PARTICLES IN THE FRIEDMANN WORLD. Chernikova, E. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 12p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.00.

The quantum field theory is used to construct a statistical model of the spherical Friedmann world the geometric properties of which are defined as of the massless scalar particle gas. (auth)

1808 GENERALIZATION OF EINSTEIN UNIVERSE TO MAGNETOHYDRODYNAMICS. Shaha, R. R. (Shivaji Univ., Kolhapur, India). J. Shivaji Univ.; 5: No. 10, 27-30(1972).

It is well known that there exist three possibilities for a homogeneous static universe characterized by the line elements of Einstein, de Sitter and Minkowski. Adopting Lichnerowicz's formulation (1967) of the field equations for relativistic magnetohydrodynamics, it is established that for a spherically symmetric static space-time filled with isentropic perfect fluid with constant magnetic permeability and infinite conductivity, the assumption of constant pressure implies the existence of three types of universes, characterized by the line elements of Nordstrom, Minkowski and an extension of Einstein universe. In the absence of magnetic field, the new solution agrees with Einstein cosmological model. (auth)

1809 SPACE–TIMES ADMITTING GROUP OF SCREW-MOTIONS. Khade, V. D. (Shivaji Univ., Kolhapur, India). J. Shivaji Univ.; 5: No. 10, 31-34(1972).

In an attempt to investigate the gravitational field due to particles which have a built-in chirality, the one parameter group of screw motions is considered. The screw-symmetric space-time was determined by solving Killing equations. (auth)

1810 ENERGY OF A RELATIVISTIC PARTICLE IN THE GENERAL RELATIVITY. Korkina, M. P.; Gladush, V. D. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 82-84(Jan 1974). (In Russian).

Different definitions are considered for the energy of a relativistic particle in the general relativity. It is shown, only Zelmaner's definition has a physical sense in any gravitational fields — it is the energy of a particle measured by the local observer. Norlicar's definition has no direct physical sense. Landau's definition determines the full energy of a particle in static gravitational fields. (auth)

1811 GEOMETRIC APPROACHES TO RELATIVISTIC KINEMATICS. Yaccarini, A. (Univ. Laval, Quebec). Can. J. Phys.; 52: No. 1, 40-48(1 Jan 1974).

A comparison is made between three methods for visualizing the Minkowski space, in view of their application to relativistic kinematics. The velocity manifold method, in which a vector is represented by a point on the upper sheet of the unit-radius hyperboloid, presents two advantages: there is no distortion of angles, and the method is independent of the choice of any particular frame or observer. It is, however, limited to the representation of positive timelike vectors. The Cayley map method allows the representation of spacelike as well as timelike vectors, but it has two drawbacks: it distorts the angles, and it depends on

the choice of a reference system. In the third method, the use of a unified space-time formalism permits one to visualize any kind of vector. This method generalizes the velocity manifold method, and presents the same two advantages: it provides one with a conformal representation, which is independent of any particular observer. A rather concise comparison between two covariant methods of calculation, considered from the point of view of relativistic kinematics, is presented. One method is the familiar tensor calculus; the other is the spinor calculus, based on the representation of four-vectors by matrices. (auth)

1812 NON-STATIC SPHERICALLY SYMMETRICAL SOLUTIONS OF EINSTEIN'S EQUATIONS. Korkina, M. P. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 19: No. 1, 40-43(Jan 1974). (In Russian).

It is shown that the nonstatic spherically symmetrical solutions of Einstein's equations may be divided into two groups. The space-time of the first group (it describes hyperbolic and parabolic movement in general relativity) has only one true singularity. It is not complete space-time. The space-time of the second group (it describes the elliptical movement) has two true singularities, describes the movement of coming and going away of particles. In this meaning this space-time is complete. In a particular case the solution of the second group contains only the T-region and has no Euclidian analogy. (auth)

1813 EINSTEIN'S STATIONARY SPHERICALLY SYMMETRIC CLUSTER OF PARTICLES. Teixeira, A. F. daF.; Som, M. M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 21: No. 2, 25-32(1973).

It is shown that Einstein equations allow a special class of stationary solutions which correspond to spherically symmetric clusters of particles in circular motions, the total angular momentum of the cluster being zero, and all orbits being performed with the same period. The mass density of such clusters is everywhere regular and positive, decreasing with increasing radius. No restriction is found either on the radii of the clusters, or on the value of the period of the orbits. (auth)

1814 NOTE ON A PARADOXICAL PROPERTY OF THE SCHWARZSCHILD SOLUTION. Abramowicz, M. A.; Lasota, J. P. (Inst. of Astronomy, Warsaw). Acta Phys. Pol.; B5: No. 2, 327-329(1974).

An analysis is made of the motion of some special observers moving in the Schwarzschild gravitational field. (auth)

1815 PHYSICAL INTERPRETATION OF THE COSMIC TERM IN GRAVITY. Kuronuma, E. (Yamagata Univ., Japan). Yamagata Daigaku Kiyo, Shizenkagaku; 8: No. 1, 37-42(Jan 1972).

First, the possibility of the growth of positrons into protons is considered, and an idea of the unified field is given. Next, the physical meaning of the cosmic term in gravity is considered in connection with the classical equation of the Newtonian potential in its revised form, $\Box\phi - \Lambda\phi = 4\pi G\rho$; its exact solution reads as $\phi = -\int \exp(-\sqrt{\Lambda}r) G\rho_0 dv/r, \rho(r, t - r/c) = \rho(o,t) \exp(-\sqrt{\Lambda}r)$; and one gets the "cosmic gravitational potential" $\Phi = \int_0^\infty d\phi = -4\pi G\rho_0/\Lambda = -c^2$. The equation of the meson-field in vacuum, $(\Box - \lambda^2)U = 0$, is recited, and the graviton-mass is estimated: $m_G = 10^{-65}$ gm. Lastly, an exact solution of the Einstein equation of gravity in the evolving universe is given, and the value of the cosmological constant Λ is proved to accord exactly with the classical consideration. (auth)

1816 CONSEQUENCES OF FIELD QUANTIZATION IN De SITTER TYPE COSMOLOGICAL MODELS. Tagirov, E.A. (Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, USSR). Ann. Phys. (N.Y.) 76: No. 2, 561-579 (Apr 1973).

The present paper may conditionally be divided into three tightly associated parts. The first part is a discussion of the necessity of conformal covariance of the general relativistic scalar field equation following from quantum field theory. The second part is an objection against the assertion or implication in Refs. [3,5] that in the De Sitter world (and as a consequence, in some other cosmological models) the rest mass of the scalar particle cannot be zero. In the third part the forbiddenness of the cubic self-interaction of the scalar field vs. the quartic one in cosmological models under consideration is shown. This forbiddenness manifests in that there exist divergences of a special type (not ultraviolet) in perturbation theory for the former interaction, but there is no such divergence for the latter. The relation of the results with the reality is discussed. (auth)

1817 STRESS TENSORS AND CONFORMAL PROPERTIES OF MASSIVE AND MASSLESS SPIN 2 FIELDS. Deser, S. (Laboratoire de Physique Théorique et Hautes Energies, Orsay, France). Ann. Phys. (N.Y.) 76: No. 1, 189-201 (Mar 1973).

Properties of stress tensors of massive and massless spin 2 fields and their relation in the limit m→0 are analyzed. The massive stress tensor effectively limits to a sum of three disjoint parts corresponding to independent massless spin 2, 1 and 0 fields. Behavior of the massless theory, including general relativity, under dilations and conformal transformations is considered. It is only scale, but not conformal, invariant. (auth)

1818 GRAVITATIONAL COLLAPSE AND HIGHER-ORDER GRAVITATIONAL LAGRANGIANS. Michel, F.C. (Institute for Advanced Study, Princeton, New Jersey 08540). Ann. Phys. (N.Y.) 76: No. 1, 281-298 (Mar 1973).

A general form of higher-order contributions (in R_0) to the Einstein field equations is displayed. The additional terms may either stabilize or destabilize self-gravitating objects in gravitational collapse depending on the sign of the coefficient introducing the quadratic term. If the quadratic term is stabilizing, inertial mass can be converted to radiation with an efficiency approaching 100%, and arbitrarily large masses can be stabilized. On the other hand, the resultant field equations are pathological in that they admit gravitons with negative mass-squared (i.e., tachyons). A nonsingular class of vacuum solutions exist in general for the quadratic ("grey dimples"). (auth)

1819 UNIFIED THEORIES OF EINSTEIN AND SCHROEDINGER. Rao, J. R. (Indian Inst. of Tech., Kharagpur). J. Math. Phys. Sci.; 6: No. 4, 381-418(1972).

A resume of the unified theories of Einstein and Schrödinger together with the work of other authors in connection with these theories is presented. (104 references) (Indian Sci. Abstr.)

1820 PARTICLE CREATION FROM VACUUM BY NONSTATIONARY GRAVITATIONAL FIELD IN THE CANONICAL FORMALISM. Grib, A. A.; Levitskii, B. A.; Mostepanenko, V. M. (Leningrad State Univ.). Teor. Mat. Fiz.; 19: No. 1, 59-75(Apr 1974). (In Russian).

Particle creation from vacuum in the isotropic and anisotropic models of the universe is considered. By the method of the diagonalization of the Hamiltonian with the aid of Bogoliubov's transformations, exact expressions for the particle densities and the vacuum expectations of energy-momentum tensor of the created pairs are obtained. It is shown that near the singularity the state equation of the created matter will be $p \approx \epsilon/3$. The problem of back influence of particle creation upon metrics is investigated. (auth)

1821 SPACETIMES ADMITTING GROUP OF SCREW-MOTIONS. Khade, V. D. (Shivaji Univ., Kohlapur, India). J. Shivaji Univ.; 4: No. 8, 31-34(1971).

In an attempt to investigate the gravitational field due to particles which have a built-in "chirality", the one parameter group of screw motions is considered. The "screw-symmetric" space-time was determined, by solving the "Killing equation". (23 references) (Indian Sci. Abstr.)

1822 SUPERPOSITION OF PERFECT FLUID AND ELECTROMAGNETIC FIELDS IN SPHERICALLY SYMMETRIC SPACE-TIME IN GENERAL RELATIVITY. Singh, K. P.; Srivastava, M. C. (Banaras Hindu Univ., India). Proc. Indian Acad. Sci., Sect. A; 40: No. 4, 372-382(1970).

In obtaining a solution of the field equation of general relativity the energy-momentum tensor employed is either that of material distribution or of electromagnetic distribution. It is examined whether the super-position of the two fields is consistent within the framework of general relativity. Such a super-position is possible in case when the material field consists of perfect fluid distribution and the space-time is spherically symmetric. In the special case of the distribution of discrete particles and the density and the electromagnetic energy were expressed in terms of the metric potentials. (Indian Sci. Abstr.)

1823 TIME DELAY OF RADAR ECHO AS A TIME DEFECT OF THE DESYNCHRONIZATION OF ULTRARELATIVISTIC PARTICLES. Levashev, A. E.; Susurin, G. E. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 63-69(1973). (In Russian).

The time desynchronization of radar echoes in the Schwarzschild field is examined as a defect of the time desynchronization of ultra-relativistic particles emitting radar signals, and being propagated with group velocity. Nonisotropic tetrads, obtained by means of local Lorentz transformations, are derived. (tr-auth)

1824 COVARIANT QUANTIZATION OF THE GRAVITATIONAL FIELD. Faddeev, L. D.; Popov, V. N. (Inst. of Mathematics, Leningrad). Usp. Fiz. Nauk; 111: No. 3, 427-450(Nov 1973). (In Russian).

For the review contemporary methods of quantization of the gravitational field are discussed. Because of its application to the theory of elementary particles, only the asymptotic two-dimensional gravitational field is examined. The method of quantization of calibration fields in the continual integral for-

malism is used as the basis of the approach studied. The formulation of covariant principles of the diagram perturbation theory is the basic result. Its elements are graviton lines, graviton-graviton interaction vertices, lines characteristic for the calibration field theory of virtual vector particles, and vertices of their interaction with gravitons. Expression for lines and vertices are derived in explicit form. It is shown that the presence of virtual particles in the covariant diagram technique guarantees unitarity of the theory and compatibility of the covariant quantization with canonical. (tr-auth)

REACTOR TECHNOLOGY AND REGULATION

1825 NUCLEAR POWER: ITS SCOPE AND FUTURE. Grant, W. L. (Atomic Energy Board, Pretoria). Trans. S. Afr. Inst. Elec. Eng.; 62: No. 4, 80-87(Apr 1971). (In Afrikaans).

A general survey of nuclear power and various types of reactors is given. The possible role of smaller countries particularly that of South Africa, in developments in the field of nuclear power, is considered. Future possible developments in South Africa in the field of nuclear power are discussed. Mention is made of various applications of nuclear power. (auth)

1826 NORWAY'S ENERGY SUPPLY UNTIL THE YEAR 2000. Nuclear Power as Energy Source. Lingjaerde, R. O. (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl.; 121: No. 5, 7-15 (31 Jan 1974). (In Norwegian).

In presenting nuclear power as a suitable means of supplementing Norway's hydroelectric power resources the main technical features of BWR and PWR are briefly presented and the fuel cycle described. The treatment of irradiated fuel and disposal of radioactive wastes are discussed, it being stated that these functions would be carried out abroad. The potentialities of plutonium as a fuel are presented and a discussion of reactor safety gives as a conclusion that 100% safety has been achieved. (NO)

1827 PRESENT STATE AND PROBLEMS OF POWER REACTOR DEVELOPMENT. Genshiryoku Chosa Jiho; No. 24, 1-29 (Apr 1973). (In Japanese).

Development of power reactors in Japan is proceeding, being centered around Power Reactor and Nuclear Fuel Development Corporation (PNC). Though somewhat behind original schedule, construction of an experimental FBR and a prototype ATR and design of a prototype FBR are in progress. The present state of power reactor development in Japan and the problems encountered are reviewed. The significance of the development efforts centered around PNC, reliance on foreign technology, prospects for domestic fuel production, the prototype ATR, engineering problems, budget systems and reactor-plant construction contracts, and management of the program are described. (JA)

1828 REPORTS FROM THE WORLD NUCLEAR POWER STATION SITES. I. Nucl. Eng.; 19: No. 214, 141-157(Mar 1974).

The first of two sections of a world review giving brief reports on the status of construction or operation at sites where nuclear power stations are either being built or have recently been commissioned is presented. Part 1 covers Argentina, Austria, Brazil, Canada, Finland, France, Germany, India, Italy, Japan, Netherlands, Pakistan, Spain. (UK).

1829 NUCLEAR POWER PLANT: AN INTEGRATED ANALYSIS. Jayaramaro, G. (SERC, Madras). Indian Eng.; 15: No. 12, 1-7(1971).

A survey of the practices followed in design and construction of nuclear power plants is made. The basic principles of instrumentation and testing of the plants are also discussed. (Indian Sci. Abstr.)

1830 ACTINIDE NITRIDE FUELED REACTOR AND CONTINUOUS METHOD OF OPERATING SAME. Anderson, R. N.; Parlee, N. A. D. (to Parlee-Anderson Corp.). Canadian Patent 931,673. 7 Aug 1973.

A nuclear reactor in which uranium is continuously separated from plutonium and fission products is described. The core of the reactor contains a critical mass of UN or U_2N_3 and a noncritical amount of uranium solution in tin. The tin continuously extracts fission products and plutonium as they are formed, and the solution is continuously removed from the reactor core. Extracted uranium is precipitated as nitride by reaction with nitrogen, and returned to the core with fresh molten tin. The tin solution can act as coolant. (CA)

1831 ACTINIDE NITRIDE FUELED REACTOR AND CONTINUOUS METHOD OF OPERATING SAME. Anderson, R. N.; Parlee, N. A. D. (to Parlee-Anderson Corp.). Canadian Patent 931,672. 7 Aug 1973.

Metallic uranium is separated from fission products and plutonium by dissolving it in molten tin and reacting it with nitrogen at high temperature to precipitate UN or U_2N_3. The separated nitride is then decomposed to give uranium metal by raising the temperature or lowering the partial pressure of nitrogen; alternatively, it may be converted to uranium dioxide by reaction with oxygen. Also described is a scheme for a nuclear reactor containing a critical mass of uranium nitride in contact with tin solution, in which fuel is recycled continuously during the operation of the reactor. (CA)

1832 SURVEY OF INDUSTRIAL AEROELASTIC PROBLEMS. Livolant, M. (CEN de Saclay, Gif-sur-Yvette, France); Michel, L. pp 31-49 of Recherches Actuelles et Applications Industrielles. Paris; Eyrolles (1973). (In French).

From fluid mechanics summer school; Ermenonville, France (4 Sep 1972).

Aerohydroelastic processes are discussed and a classification developed of the different phenomena from their characteristics: interaction between structure and flows; external and internal flows; and nature of the fluid and obstacles. Examples of the manifestations of vibrational phenomena induced by the flow are presented: effect of winds on atmospheric structures; vibrations developed by coolant fluids on the internal structures of nuclear reactors; vibrations occurring in tube systems excited by internal flow; aerohydroelastic phenomena in turbomachines. (FR)

1833 INDUSTRIAL OPERATION EXPERIENCE. Stolz, J. (Electricite de France, Saint Denis). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 102, 21-32(Jul 1973). (In French).

From fifth foratom congress on nuclear power plants in Europe; Florence, Italy (15 Oct 1973).

The conditions under which the power plants Chinon 1, Chinon 2, Chinon 3, Saint-Laurent 1, Saint-Laurent 2, Bugey 1, and EL4 have been used up until 31/12/72 are reviewed. The operational conditions of these reactors are discussed: performance (nonavailability for use, incidents, maintenance); fuel charging cycle; safety and protection of the environment under normal operating conditions (radioactive effluents, heating of rivers). (FR)

1834 ABSENCE OF BURST SLUGS IN FRENCH ELECTRONUCLEAR REACTORS DURING 1972. Gauthron, M. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Fr. Energ.; No. 255, 401-405(Jul 1973). (In French).

The year 1972 was exceptional inasmuch as no burst slug incidents occurred with any of the nominal fuel elements used in French reactors: the 7 graphite gas power plants (Chinon 1, 2, and 3; Saint-Laurent-des-Eaux 1 and 2; Bugey 1; and Vandellos), heavy water-gas type reactors, EL 4, and the fast neutron reactor, RAPSODIE. This result was obtained in spite of the fact that the charge factor of all these reactors had, on average, been raised. The nature of burst slugs is recalled together with their consequences and causes. The different burst slug incidents having occurred up to the end of 1971 with French nuclear reactors are presented in the form of a table. (FR)

1835 UTILIZATION OF TESTED, ADVANCED, AND FAST REACTORS. Carle, R. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 102, 68-83 (Jul 1973). (In French).

From fifth foratom congress on nuclear power plants in Europe; Florence, Italy (15 Oct 1973).

The current state and outlook for the development of the principal types of French nuclear reactor are presented. Tested reactors cover the range of those having reached the commercial stage: natural uranium-graphite-gas and ordinary water. The construction programs, technical improvements envisaged, economic outlook for small plants (300 MWe) and for large plants are considered together with long term prospects. Advanced reactors include those operating at high temperatures (HTR), the operation of which is recalled: increase in the outlet temperature of the coolant in order to improve the thermodynamic yield using a helium cooled enriched refractory fuel. Up until 1972 French research concerned the standard Dragon particle and two types of fuel elements. Since 1972, the research conducted concerns the standard Gulf fuel within the framework of the Gulf-CEA agreements on the Gulf type vapor cycle HTR. Technological progress is envisaged together with improvements to this type of reactor and its economic future. The French fast neutron reactor programs led to the construction of the experimental reactor, RAPSODIE, to the prototype, PHENIX, and to the SUPER PHENIX project. (FR)

Power Reactors, Non-Breeding, BWR-Type

Refer also to abstracts 1933, 2071, 2075, 2077, 2089, 2169, 2170, 2188, and 2189.

1836 (AEE-R-928) REVIEW OF TWO-PHASE MIXING AND DIVERSION CROSS FLOW IN SUBCHANNEL ANALYSIS.

Weisman, J. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Sep 1973. 18p. Dep. NTIS (U. S. Sales Only) $4.00.

The status of the current knowledge of diversion cross flow and two-phase mixing, as applied to subchannel analysis of water-cooled rod bundles, is reviewed. Uncertain areas are discussed and suggestions for further development are made. (32 references) (auth)

1837 (ORNL-NSIC-55(Vol.3)) DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS. Vol. III. Docket No. 50-397 Through 50-449. Heddleson, F. A. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 141p. Dep. NTIS $10.25.

Design data, safety features, and site characteristics are summarized for 33 nuclear power units in 17 power stations in the United States. Six pages of data are presented for each plant consisting of Thermal-Hydraulic and Nuclear Factors, Containment Features, Emergency Core Cooling Systems, Site Features, Circulating Water System Data, and Miscellaneous Factors. An aerial perspective is also presented for each plant. Those covered in this volume are Hanford No. 2, Docket Number 50-397, and all subsequent plants finishing with Douglas Point, Docket Number 50-448, 50-449. (auth)

1838 (ORNL-NSIC-113) SELECTED BIBLIOGRAPHY ON EMERGENCY CORE COOLING SYSTEMS (ECCS) FOR LIGHT-WATER-COOLED POWER REACTORS (LWRs). Cottrell, W. B. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 188p. Dep. NTIS $12.00.

In preparation of this bibliography, the Nuclear Safety Information Center's computerized files were searched for all relevant literature from 1968 to the fall of 1973. With this date limitation, the initial NSIC search identified some 2500 documents associated in some manner with ECCS. However, this large number was reduced to the approximately 500 documents by the elimination of all documents dealing with the licensing and/or operation of specific reactors (approximately 1500), and by the elimination of documents on peripheral topics (approximately 500). The 500 documents remaining were reviewed and sorted into ten categories for presentation in this bibliography. Although every reasonable effort was made to identify all the relevant literature in each category, it should be noted that the AEC literature does not include the informal periodic (generally monthly) progress reports which the Commission requires of its contractors. Somewhat similarly, there is relatively little public documentation available on the research which the reactor vendors undertake with their own funds. (auth)

1839 (WASH-1303) EFFECTS OF PLUTONIUM UTILIZATION ON THE PERFORMANCE OF LIGHT WATER REACTORS. (USAEC Regulatory Staff, Washington, D. C.). Apr 1974. 57p. Dep. NTIS $5.45.

A generic review of the effect of recycled plutonium fuels on LWR core performance is presented. Topics covered include LWR plutonium irradiation experience, nuclear design of mixed-oxide cores, characteristics of mixed-oxide fuels, and behavior of plutonium-fueled LWRs. (48 references) (JWR)

1840 CONSTRUCTION PROGRAM OF SHIMANE NUCLEAR POWER PLANT OF CHUGOKU ELECTRIC POWER CO. Yakushiji, K. (Chugoku Electric Power Co., Hiroshima). Karyoku Hatsuden; 24: No. 2, 105-113(Feb 1973). (In Japanese).

The construction of Shimane nuclear power plant began in February 1970, and it was planned to be finished in November 1973. The outline, special features, and state of construction of the Shimane nuclear power plant are described. The reactor is a BWR type with an electric power output of 460 megawatts. The percentage of home production of this plant reaches 93%. The pressure vessel is the same as that of Fukushima-1 nuclear power plant in form, but the design standard applied to the Shimane nuclear power plant is not ASME Section VIII but ASME Section III. Pre-inservice inspection is performed on the basis of ASME Section XI. The construction of the road to the plant site and the land preparation of the plant site began in July 1969. In November 1970, the nuclear power plant passed the safety examination, and on February 11, 1972, the main construction began. The preservice inspection of the nuclear power plant was performed from April 9 to 13, 1971, and it passed the examination. The reactor vessel passed the water pressure test on August 16, 1972. About 75% of plant equipment was installed as of September 1973. (JA)

1841 DESIGN OF THE SYSTEM FOR TRANSFER OF CORE RESIDUAL HEAT OF THE CAORSO NUCLEAR POWER STATION TO THE EXTERNAL ENVIRONMENT. Senis, R.; Bolognini, G. C. (Nuclear Plants Design and Construction Center, Rome). Energ. Nucl. (Milan); 21: No. 3, 155-175(Mar 1974).

After having summed up the essential characteristics of the Emergency Core Cooling System of the Caorso Power Station, the main solutions examined during the design of the system for the transfer of core residual heat to the external environment are described. The sizing criteria of the selected system, which is based on the utilization of a wet cooling tower, are then illustrated. (auth)

1842 EXPERIMENTAL TEST ON THE USE OF PULVERIZED RESIN IN THE CONDENSATE PROCESSING OF A BOILING WATER NUCLEAR POWER PLANT. Ioannilli, E.; Stefanelli, P. Ing. Nucl.; No. 1, 3-8(1973). (In Italian).

The results of tests made at the Garigliano Nuclear Power Plant on the ion exchange capacity and the filtration efficiency of pulverized resin in the treatment of the condensate of a boiling water nuclear power plant are presented. (tr-auth)

1843 SINOD: A NONLINEAR LUMPED-PARAMETER MODEL FOR STEADY-STATE, TRANSIENT, AND STABILITY ANALYSIS OF TWO-PHASE FLOW IN NATURAL CIRCULATION BOILING-WATER LOOPS. Matausek, M. R. (Inst. Boris Kidric, Belgrade). Nucl. Sci. Eng.; 53: No. 4, 440-457(Apr 1974).

The loop considered consists of an equivalent downcomer and a channel divided into a heated test section and an unheated riser. The preliminary structure of the lumped-parameter model is obtained by integrating partially, over the space coordinate, the system of nonlinear partial differential equations that state the mass, energy, and momentum conservation. The same formalism, however, should not be used for specifying the final structure of the model; it is shown that in this way it is not possible to represent adequately the basic mechanism of hydrodynamic instability, i.e., to define the interaction between the mass velocity and the void fraction, resulting from the friction in the boiling part of the heated test section. A procedure is proposed for specifying the final structure of the lumped-parameter model that can be adequately used instead of distributed parameter models in a wide range of system parameters and operating conditions. The model SINOD is formulated in terms of four nonlinear first-order ordinary differential equations and one time lag. Since the time lag can be neglected in most analyses, the model reduces to a system of only three nonlinear first-order ordinary differential equations. An important particularity of the model is that both the steady-state and the dynamic calculations can be performed by solving the same system of differential equations. The input data are the parameters specifying the geometry of the test loop, the physical parameters of the fluid, the channel inlet, and the riser outlet pressure drop coefficients. The two-phase friction multiplier and the slip ratio correlations are arbitrary. The validity of the proposed model is examined by comparing the results with the experimental data obtained on the test loops FROJA, FRIGG, SKALAVAN, and Halden Loop, as well as with the results obtained using the distributed parameter models HYDRO and RAMONA. (auth)

1844 NUCLEAR REACTOR HAVING MEANS FOR CLAMPING A STEAM TREATING UNIT. Gunnarsson, C. (to Aktiebolaget Asea-Atom). U. S. Patent 3,793,142. 19 Feb 1974. Priority date 11 Oct 1971, Sweden. 6p.

In a nuclear reaction which includes a reactor tank with a lid and a steam treating unit including a moderator tank lid with steam separators attached to it and a steam drying unit arranged above the lid of the moderator tank, in order to clamp the steam treating unit members are secured in the lid of the reactor tank which exert a pressure on the steam treating unit and press it against the moderator tank when the lid is applied on the reactor tank. These members may be elastically deformable beams fixed on the ends to the reactor tank lid and arranged in a polygonal formation for exerting a clamping pressure during steam treating which is greater than the forces which may arise from a normal type of accident. (Official Gazette)

1845 NUCLEAR REACTOR UTILIZING PLUTONIUM IN PERIPHERAL FUEL ASSEMBLIES. Crowther, R. L. (to General Electric Co.). Canadian Patent 923,224. 20 Mar 1973.

Particularly in a reactor of the boiling-light-water type, utilization of plutonium only round the periphery of the core has the advantages of increasing the power density in that region, flattening the power density of the core, minimizing the number of fuel elements that contain plutonium, and simplifying refueling. The proportion of plutonium in individual rods of the peripheral fuel elements may be varied to be inversely proportional to the thermal-neutron flux distribution. The enrichment of fuel in the central region may also be varied so as to flatten the axial distribution of neutron flux. An intermediate group of fuel elements may separate the central and peripheral groups. (CA)

1846 METHODS USED AT KEMA FOR MEASURING IODINE ADSORPTION ON CHARCOAL AND EXPERIENCES WITH

CHARCOAL FILTERS INSTALLED IN A NUCLEAR POWER PLANT. van der Lugt, G.; Scholten, L. C. (Keuring van Electrotechnische Materialen NV, Arnheim, Netherlands). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

At the KEMA reactor laboratory an installation is built for the measurement of the adsorption of iodine by small beds of charcoal. The temperature, humidity, dimensions of the bed and the flow velocity of the air in the bed are variable. A description of the apparatus is given, especially the differences in comparison with other similar installations. Methods for in-situ testing of charcoal filters are described. Experience with iodine filters installed since 1968 in the Dodewaard nuclear power plant are given. Samples of charcoal used in these filters were measured periodically at our laboratory. (GE)

1847 MEASUREMENTS OF THE IODINE COMPOSITION IN THE PLANT ENCLOSURES OF A BWR NUCLEAR POWER PLANT. Pfeiffer, K. W. (Kraftwerk Union AG, Frankfurt am Main). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Fission-product iodine released by coolant leakage into the air in the rooms and buildings of a nuclear power station may be present as elementary iodine, gaseous inorganic or organic bound iodine, or as aerosol. The composition depends on the operating conditions at the time of release. To determine approximately the proportions of the various iodine components, experiments were carried out in a BWR nuclear power plant with various filter media, using the multi-filter method. Particulate filters, fiber filters, activated charcoal filters, KI-impregnated activated charcoal filters, and silver nitrate-impregnated catalyst carrier AC-6,120 were used. The results obtained so far indicate that the component readily trapped by fiber filters (aerosol iodine) accounts for 30–40% of the total. The fraction of components readily absorbed by normal activated charcoal is 50–60%, while the fraction of components which are difficult to remove by filtration is below 10%, ranging from 3 to 6%. With simulated leakages in an experimental chamber the proportion of aerosol iodine was sometimes as high as 80%. (GE)

1848 CORE AND REFLECTOR TEMPERATURE-REACTIVITY EFFECTS IN A BWR REACTOR. Khan, A. M. (Pakistan Atomic Energy Commission, Karachi); Gallar, O. H. Atomkernenergie; 22: No. 4, 242-247(1974).

The effects of the variation of reflector and moderator densities and fuel temperatures on the reactivity of a boiling water reactor, were studied. The DRESDEN-1 fuel assembly was chosen as a model for calculations. Each assembly contains 36 cylindrical fuel rods 0.5″ in diameter with 0.03″ thick zirconium cladding and placed 0.71″ apart in a square array. These rods are contained in a zirconium sheath 0.055″ thick. The model consists of a cylindrical core made of homogenized assemblies surrounded by a thick cylindrical reflector. Moderator and reflector densities were varied from 0.44 g/cm^3 to 1.00314 g/cm^3 (280°C and 40% void to 0°C and 0% void). The fuel temperature was changed from room temperature to near its melting point. A combination of LASER, HRG, TEMPEST, FOG and EQUIPOISE computer programs was used for criticality and cross section calculations. It is shown that for all moderator and fuel temperatures, there is a positive temperature coefficient as the reflector temperature is raised from 4.4°C to 260°C and that the maximum k_{eff} corresponds to a moderator temperature of 4.4°C. Iso-k_{eff} curves and 3-dimensional iso-k_{eff} surfaces with fuel temperature, reflector and moderator densities as coordinates, have been generated. Using these surfaces it is possible to predict numerous combinations of fuel, moderator and reflector temperatures that would yield a given k_{eff}. (GE)

1849 DEVELOPMENT OF A GE-BWR STARTUP PROGRAM. Hurd, R. O. (General Electric Co., San Jose, CA); Rubino, L. F. Proc. Amer. Power Conf.; 35: 246-252(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The GE-BWR Startup Program was developed over a total of 23 plant startups. A typical program involves 30 to 40 startup tests that are performed at a number of appropriate power levels during initial power ascension. Preoperation tests are completed on each plant system. The Startup Program includes fuel loading, initial heatup, power testing, and warranty demonstrations. Comparisons are made of present-day start-up programs and of early GE-BWRs. The development of the standard Startup Test Program for a BWR based on the utility, vendor, and the AEC requirements is traced. (MCW)

1850 ENRICO FERMI UNIT 2: CONDENSER OFF-GAS SYSTEM. Schuerman, L. E. (Detroit Edison Co.); Sack, L.; Schanz, J. L. Proc. Amer. Power Conf.; 35: 341-347(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The condenser off-gas system to be installed in the Enrico Fermi-2 Reactor was developed and will be supplied by AEG-Telefunken of West Germany. The system consists of catalytic recombiners followed by a series of charcoal adsorber vessels that operate at ambient temperature and subatmospheric pressure and will provide an additional reduction factor of 100 relative to a 30-minute holdup system. The typical condenser off-gas systems for a BWR had originally consisted of a 30-minute delay pipe, but Federal regulations now specify that the release of activity be reduced to a value that is as low as practicable. (MCW)

1851 PERFORMANCE OF LARGE NUCLEAR TURBINES. Spencer, R. C.; Miller, E. H. (General Electric Co., Schenectady, NY). Proc. Amer. Power Conf.; 348-357(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

A summary is given of the experience gained from the operation of large steam turbine-generators in Dresden-1; Hanford-1 and -2; Dresden-1, -2, and -3; Hanford-1 and -2; Oyster Creek-1; Nine Mile Point-1; Millstone-1; Monticello-1; Quad Cities-1 and -2; Pilgrim-1; and Vernon-1. The major problems that were encountered, their solutions, and the performance record in terms of reliability and efficiency are considered. (MCW)

1852 IMPACT OF POWDERED ION-EXCHANGE RESINS FOR WATER TREATMENT ON BWR OPERATIONS. Ryan, L. F. (Graver Water Conditioning Co., Union, NJ). Proc. Amer. Power Conf.; 35: 864-874(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

Experience with powdered ion-exchange condensate treatment systems demonstrates the benefit of permitting minimized liquid radwaste discharge without resorting to installation and operation of a large number of concentrators or otherwise expanding radwaste plants. The powdered ion-exchange systems also permitted time savings during initial flushing operations. Effects of radwaste considerations on economic evaluations and recent operating experiences with powdered ion-exchange and deep-bed systems are discussed. Radioactive liquid release from plants employing different condensate purification systems are described for Monticello, Vermont Yankee, Quad Cities 1 & 2, Big Rock, Dresden 1, 2, & 3, Pilgrim, Oyster Creek, and Nine Mile Point. 21 references. (MCW)

1853 CHEMICAL CLEANING PROGRAM FOR BROWNS FERRY NUCLEAR PLANT. Cain, C. Jr.; Greco, J.; Paul, D. L. (Tennessee Valley Authority, Chattanooga). Proc. Amer. Power Conf.; 35: 883-891(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The cleaning procedure for Browns Ferry-1 Reactor was described. TVA had followed much the pattern used on fossil-fired units, but the system was expensive and lengthy. A more economical and less time-consuming approach was selected for Unit 2, consisting of mechanical cleaning before erection and a less complex chemical cleaning. Unit 3 will be cleaned in like manner. The procedures are described. Disposal of spent solutions and the continuous river or pond monitoring during cleaning are discussed. (MCW)

1854 CALCULATING THE PROCESS OF UNSTEADY HEAT TRANSFER IN STEAM GENERATORS WITH A SINGLE-PHASE INCOMPRESSIBLE HEAT CARRIER WITH ALLOWANCE FOR THE DISTRIBUTION OF PARAMETERS OVER THE LENGTH. Burkrinskii, A. M.; Pevzner, V. I. Therm. Eng. (USSR) (Engl. Transl.); 20: No. 5, 108-110(May 1973).

Translated from Teploenergetika; 20: No. 5, 78-79(May 1973).

A method for solving the problem of unsteady heat transfer in the steam generator of a nuclear power station operating on saturated steam is presented. The solution covers the case when the unsteady process takes place simultaneously with a varying flowrate. The results are of practical use in calculating the emergency conditions of water-cooled and -moderated reactors. (JWR)

1855 THREE-DIMENSIONAL CORE MODEL FOR THE DETERMINATION OF THE NONSTEADY POWER DISTRIBUTION IN THE OPERATION RANGE OF BOILING WATER REACTORS. Schmidt, A. (Technische Univ., Munich). (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and

Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

From the three-dimensional computer program PIMFUX for fast reactivity excursions, a special version with thermo-hydrodynamic feedback was developed. The model allows the simulation of perturbances caused by control rod movements or changes of coolant characteristics at the core inlet. It can only be used at present to describe the special problems of boiling water reactors. (GE)

1856 NONLINEAR PLANT MODEL FOR THE CALCULATION OF TRANSIENTS IN BOILING WATER REACTORS. Frisch, W.; Langenbuch, S. (Technische Univ., Munich). (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

A program system for the simulation of transients is described. It is based on different versions tailored to the different causes of disturbances (control rod failure, subcooling, etc.). The model is tested by a comparison of measurements and calculation, and possibilities of further development and improvement are reported. (GE)

1857 CIRCULATING SYSTEM FOR A NUCLEAR PRESSURE VESSEL. Schill, J. (to Sulzer Brothers Ltd.). Canadian Patent 935,944. 23 Oct 1973.

In boiling-light-water (BWR) reactors, a standard design uses turbines driven by the flow of feedwater to turn circulatory pumps inside the actual core of the reactor. The improvement claimed is to connect several such water turbines in series, with regulatory valves between them, so that the pressure drop across each turbine is not excessively high. Various arrangements are described. (CA)

1858 CALCULATION OF THE TRANSIENT BEHAVIOR OF LIGHT WATER REACTORS USING LAPLACE-TRANSFORM TECHNIQUES. Hoeld, A. (Technische Univ., Munich). (1974). vp. (In German).

From experts meeting of the task groups thermodynamics and fluid dynamics and reactor physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

With a computer program called FRETI (abbreviation for frequency-time transformation) it is shown that transient calculations can be done with good success using Laplace-transform-techniques. The advantages of this method in comparison with the well-known time models is a remarkable saving of calculation time and storage place. (GE)

1859 CRITICAL QUANTITIES OF LIGHT-WATER REACTORS IN THE INVESTIGATION OF UNSTEADY PROCESSES. Reinhardt, A. (Fachhochschule, Hanover). (1974). vp. (In German).

From experts meeting of the task groups thermodynamics and fluid dynamics and reactor physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

A survey is given of the auxiliary means like analog computers, digital computers, analog simulators and hybrid computers, which are used for the calculation of unsteady events in light-water reactors. Besides the system pressure, the maximum fuel temperature and the transition to film boiling are treated in particular as the most important critical quantities. (GE)

Power Reactors, Non-Breeding, PWR-Type

Refer also to abstracts 931, 1836–1839, 1854, 1858, 1859, 1933, 2071, 2075, 2077, 2087, 2088, 2153, 2165, and 2173.

1860 (ANCR-1143) $1\frac{1}{2}$ LOOP SEMISCALE ISOTHERMAL TEST PROGRAM: PROGRAM AND SYSTEM DESCRIPTION IN SUPPORT OF EXPERIMENT DATA REPORTS. Naff, S. A.; Pinson, P. A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Feb 1974. Contract AT(10-1)-1375. 45p. Dep. NTIS $5.45.

The isothermal test series is part of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project conducted by Aerojet Nuclear Company for the U. S. Atomic Energy Commission. The test series consisted of ten blowdown tests and five hot-wall tests with emphasis on emergency core coolant delivery. The blowdown tests were conducted to investigate the effects of lower plenum geometry, heat transfer configuration, ECC injection location, downcomer gap size, and break size. The hot-wall tests were conducted to investigate the effects of residual vessel wall heat on ECC delivery after blowdown was completed. The test system included a pressure vessel with internals; an operating loop with steam generator, pump, and pressurizer; a blowdown loop with rupture assembly, simulated pump, and simulated steam generator; a pressure suppression system with suppression tank and header, and a simulated ECC system with accumulators and injection pumps. The isothermal test program, $1\frac{1}{2}$-loop semiscale system, experimental instrumentation, operating procedures, and test conditions are described in this report to provide a reference document for support of the data reports specific to one or more of the isothermal tests. (auth)

1861 (ANCR-1147) EXPERIMENT DATA REPORT FOR $1\frac{1}{2}$ LOOP SEMISCALE SYSTEM ISOTHERMAL TEST 1014. Feldman, E. M.; Pinson, P. A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Mar 1974. Contract AT(10-1)-1375. 52p. Dep. NTIS $5.45.

Recorded test data are presented for Test 1014 of the isothermal portion of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project. The data represent the results of an isothermal test utilizing an enlarged downcomer gap (1.0 inch) to investigate system hydraulic response during blowdown without simulated ECC injection. The test was a single-ended break test in which only one of the rupture assemblies actuated. The data, presented in the form of graphs in engineering units, have been analyzed only to the extent necessary to assure that they are reasonable and correct. The intent of this report is to make available the uninterpreted data from Test 1014 for use by others and for support of subsequent interpretative reports and analyses. (auth)

1862 (DOCKET-50282-229) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT 1. Semiannual Operating Report No. 1, August 9, 1973–December 31, 1973. (Northern States Power Co., Minneapolis, Minn. (USA)). 28 Feb 1974. 107p. Dep. NTIS $8.50.

An operations summary is presented, which includes chronological history, changes in plant design, performance characteristics, procedure changes, results of surveillance tests and inspections, containment leakage tests, changes in operating organization, and occupational personnel radiation exposure. Information is given on power operation and maintenance, tests, experiments, radioactive effluent releases, and radiological environmental monitoring. (FS)

1863 GENKAI NO. 1 NUCLEAR POWER PLANT, AND STATE OF ITS CONSTRUCTION. Shiraishi, S. (Kyushu Electric Power Co. Inc., Fukuoka). Karyoku Hatsuden; 24: No. 3, 238-251(Mar 1973). (In Japanese).

Kyushu Electric Power Company has decided on the building of the Genkai No. 1 nuclear power plant, a PWR facility of 559 MW(e) output. The power station is located on a hilly seaboard facing the Japan Sea in the Saga Prefecture. The plant is designed and constructed by Japanese technology. Its steam generating equipment is standard two-loop type. Construction was started in March 1971, and completion of the power plant is expected in 1975. The following are described: site conditions (geology, climate, etc.) and plant layout, specification for steam generating equipment, reactor containment vessel, turbine generator, present state of its construction, and quality control. (JA)

1864 DEVELOPMENTS IN DESIGN AND CONSTRUCTION. Leny, J. V. (Societe Franco-Americaine de Constructions Atomiques, Courbevoie, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 102, 33-44(Jul 1973). (In French).

From 5th Foratom congress on nuclear power plants in Europe; Florence, Italy (15 Oct 1973).

Developments in the design and construction of light water reactors in France during the last ten years (increase in plant power and performance improvements) are studied. These developments are illustrated by comparing two plants ordered in 1961 and 1971: the Chooz plant in the Ardennes and the Bugey II (EDF) plant. This comparison is particularly significant as both plants employ the same type of reactor (Westinghouse type (PWR) reactor) for the same operator (EDF for SENA at Chooz and for its own behalf at Bugey), the boilers having been constructed by Framatome. The performance of the two plants are compared; the progress made in the design and study of the principal components and their rationalization is presented together with safety the improvements made (legislation, norms, safety analysis). The progress made in the manufacture of components (boilers and turbo-alternators) by

French industry (Framatome, Creusot-Loire, and Vallourec Societies) and the EDF and CEA testing centers is examined. (FR)

1865 FABRICATION OF HEAVY VESSELS FOR THE DOEL AND TIHANGE POWER PLANTS. Offergeld, E. (S. A. Cockerill, Seraing, Belgium). Rev. Soudure (Brussels); 29: No. 4, 205-216 (1973). (In French).

1866 THERMAL DEGASSING OF THE PRIMARY COOLANT OF NUCLEAR REACTORS. Gramer, G.; Korn, R. (to Siemens Aktiengesellschaft). US Patent 3,789, 577. 5 Feb 1974. Priority date 30 Jan 1971, F.R. Germany. 6p.

Part of the primary coolant to be degassed is fed through the pressure maintenance device wherein the primary coolant is further heated and partially evaporated. The vaporized coolant is withdrawn from the pressure maintenance device together with the gases released from the coolant and is condensed while the released gases are removed by an adsorption device. (Official Gazette)

1867 PWR: PRESENT AND FUTURE. Dietrich, J. R. (Combustion Engineering, Inc., Windsor, CT). VGB Kraftwerkstechnik; 54: No. 1, 15-25(Jan 1974).

The development of light water reactor technology is characterized by increasing unit size. This is conditioned more by increasing capacity than by increasing dimensions. The present limit to reactor core size in the U. S. A. of 3800 MW enables one to anticipate developments which are further described together with economic and energy policy aspects. (GE)

1868 PRESSURIZED WATER REACTOR WITH AN OPEN CORE. Beese, G.; Fischer, U. (to Siemens AG). German (FRG) Patent 2,150,340. 4 Jan 1973. 4p. (In German).

The core of the described reactor is used in a core vessel through which a primary cooling medium flows. The core is clad along a circumferential line with scrubber baffles which lie perpendicular to the longitudinal axis of the core and which are supported on the spacer wires of the outer fuel elements. (GE)

1869 SITING, DESIGN, AND LICENSING CONSIDERATIONS FOR THE ATLANTIC GENERATION STATION. Kehnemuyi, M. (Public Service Electric and Gas Co., Newark, NJ); Nichols, R. C. Proc. Amer. Power Conf.; 35: 125-132(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The Atlantic Generating Station, a 2300-MW(e) nuclear generating station, will be the first commercial floating facility. It will be towed from its construction site at Jacksonville, Florida, and moored three miles off the New Jersey coast within a protective breakwater. The power from these plants is transmitted to the shore-based grid via an underground high-voltage cable buried in the ocean floor. Siting and site design, plant design and its related factors including environmental, geologic, meteorologic, and safety factors, and licensing considerations are discussed. (MCW)

1870 PWR PRACTICE IN THE UNITED STATES AND EUROPE. Abbott, W. E. (Combustion Engineering, Inc., Windsor, CT); Chernock, W. P.; Braun, W.; Martin, A. Proc. Amer. Power Conf.; 35: 148-160(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

There are no environmental (business) factors, safety considerations, or licensing rules that dictate any substantial differences in design of PWR's between the USA and Europe. The fusing of American and European PWR technology is taking place under the C-E/Siemens agreement. It is the intention over a period of years to converge the C-E and KWU PWR designs to produce improved standardized design of the nuclear steam supply system, the nuclear island, and balance-of-plant, which will be licensable and marketable in the U. S., Europe, and elsewhere. (MCW)

1871 MAINE YANKEE STARTUP AND INITIAL OPERATION. LeBlanc, J. D. (Maine Yankee Atomic Power Co., Wiscasset); Gibbons, J. F. Proc. Amer. Power Conf.; 35: 215-236(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The Maine Yankee Atomic Power Station is an 830-MW(e) power generating station near Wiscasset, Maine. The plant has a PWR nuclear steam supply system and a turbine-generator unit. The plant description, staff, licensing, and overall schedule is presented briefly. Core loading begun on September 17, 1972 and ended on September 25, 1972, the 217 fuel bundles being loaded very successfully. Initial approach to criticality commenced on Oct. 22, 1972 and was achieved on Oct. 23, 1972 at 910 ppm, 270°F, 450 psig. The measured all-rods-out critical boron concentration at this temperature and pressure was 966 ppm versus a calculated value of 929 ppm. Post-core-loading tests, low-power physics testing, reactor chemistry, and power escalation testing are described. Pre-installation, precore, and post-core performance of the NSSS equipment and the remaining equipment performance are described. (MCW)

1872 REFUELING SHUTDOWN MANAGEMENT. Lehr, R. F. (Westinghouse Electric Corp., Pittsburgh); Hartley, F. W. Proc. Amer. Power Conf.; 35: 253-260(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The refueling and major maintenance outage at a nuclear plant are factors that are included in the design planning. Efficiency and scheduling must be maintained by an expert team. Outage experiences at Connecticut Yankee Cycles I-II, II-III, and III-IV; San Onofre Cycles I-II, II-III; and Ginna Cycle I-IB, IB-II, and II-III are described. (MCW)

1873 CONSTRUCTION, TESTING, AND STARTUP OF THE OCONEE NUCLEAR STATION. Owen, W. H. (Duke Power Co., Charlotte, NC). Proc. Amer. Power Conf.; 35: 261-263(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The status of the Oconee Nuclear Station is described. The Keowee-Toxaway Development, located in western South Carolina, employs complementary forms of generation: an 18,000 acre lake with two 70-MW conventional hydro units already in service; a 5000-acre lake serving as the upper reservoir for a pumped storage plant with four 150-MW units going in service over the next 24 months; and three sites for large thermal generating units. The first of these thermal stations is Oconee, with three nuclear units, using a portion of Lake Keowee for an ultimate heat sink. The Oconee plant design was begun in 1966. A description is given of the delays encountered on Unit 1. Man-hour comparisons are made for fossil and nuclear construction. (MCW)

1874 NUCLEAR TURBINE OPERATING EXPERIENCES. Williamson, R. B. (Westinghouse Electric Corp., Lester, PA). Proc. Amer. Power Conf.; 35: 358-364(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The performance and operation history of Westinghouse nuclear turbine-generators is followed. The review shows there have been few outages resulting from malfunction of the equipment and few incidents as a result of abnormal operation. The malfunctions that did occur are described, and the resulting turbine design evolution is described. Some operation factors are described for San Onofre-1, -2, and -3; Connecticut Yankee; Ginna-1 and -2; Robinson-2; Shippingport; and Rowe Yankee. (MCW)

1875 USE OF ACTIVATION DETECTORS FOR THE INVESTIGATION OF THE SPECTRAL PARAMETERS OF THE NEUTRON FIELD IN REACTORS OF THE NOVOVORONEZH AEC. Lomakin, S. S.; Panfilov, G. G.; Petrov, V. I.; Samoilov, P. S. Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.; No. 17, 11-16(1972). (In Russian).

The results of the measurement by the integral method of the current density, effective temperature, and epithermal parameters of the neutron field in reactors of the first and second units of the Novovoronezh AEC were reported. It was shown that by use of a set of detectors, including Lu, Eu, Cu, and Au, sufficiently complete information can be obtained on the variation of these parameters in the active zone under variation of the operating conditions. (tr-auth)

1876 TIHANGE POWER PLANT. Some Civil Engineering Aspects: The Reactor Building. Chapaux, R.; Herman, A.; Kartchevsky, G. (ELECTROBEL, Brussels). J. Ing.; 22: No. 4, 7-13(1973). (In French).

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Refer also to abstracts 2073, 2154, and 2163.

1877 (GKSS-74-E-6) TEMPERATURE DISTRIBUTION IN THE ELEMENTARY CELL OF THREE INTEGRAL BLOCK TYPE FUEL ELEMENTS OF DIFFERENT GEOMETRY. Penndorf, K.; Schult, F. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geestacht-Tesperhude (F. R. Germany)). 1974. 16p. Dep. NTIS (U. S. Sales Only) $4.00.

Two-dimensional temperature fields will be calculated under stationary state conditions of an HHT-reactor. (auth)

1878 (INIS-mf-171) NUCLEAR POWER IN GREAT BRITAIN. Thoernqvist, L. (Tekniska Hoegskolan, Lund (Sweden)). Dec 1970. 40p. INIS.

The present situation of nuclear power in Great Britain is observed. The total electrical consumption corresponds to a maximum effect of 40,000 MW. The first British nuclear power program, now nearly complete, was intended for 5,000 MW during the years 1956 to 1969. Most of the reactors are of magnox-type. The second nuclear power program is currently planned to give another 8,000 MW for the period 1970 to 1975. The advanced gas cooled reactor was chosen for this program. A review is presented of the operation data of the magnox nuclear power plants. Most of the problems concerned the gas circulators and the equipment for fuel handling. Costs are reviewed, showing that the production costs for the magnox-type nuclear power plants are high compared with coal and oil heated power plants. (INIS)

1879 (JAERI-M-5368) BLOCK-TYPE REACTOR CORE THERMAL AND HYDRAULIC ANALYSIS CODE CROSS-2. Suzuki, K.; Miyamoto, Y. (Japan Atomic Energy Research Inst., Tokyo). Aug 1973. 32p. (In Japanese). NTIS (US Sales Only).

The computer code CROSS-2 is for predicting thermal and hydraulic performances of an HTGR core which consists of block-type fuel elements. Features of the code are as follows. (1) In calculating the performances of the reactor core with fuel elements stacked in columns, the large number of flow paths in the core are simulated by a one-dimensional flow network model using the one-dimensional momentum equation for incompressible flow in a duct and the continuity equations for flow and energy. (2) The set of these equations in the flow network are solved by a variation of the point relaxation method. Relaxation factors are defined for correcting the branch flow, node pressure, and linear heat rate at node. (3) The temperature distribution of a fuel pin inserted in the hole of the block is calculated with the one-dimensional differential equations of heat conduction. Calculations can be made for the various types of fuel pin such as annular, hollow, and solid. The code is written in FORTRAN IV, used with IBM 360 or FACOM 230-60 computer. For the network with 57 nodes and 92 branches, the computation time is about 0.2 second per iteration with FACOM 230-60. (auth)

1880 NUCLEAR REACTOR FUEL ELEMENT. (To Commissariat a l'Energie Atomique). French Patent 2,162,255. 7 Dec 1971. 4p. (In French).

The principal patent describes a fuel element for a high temperature nuclear reactor in which the fuel or compact has an annular form and is covered internally and externally with a felt or carbon material solidly fixed to the fuel part by pyrocarbon formed from the hydrolysis of gaseous hydrocarbons. An improvement to the basic idea is presented. It consists of impregnating the carbon or graphite felt covering the fuel with a graphite powder mixed with a thermohardenable material which is then subjected to a polymerizing heat treatment, to a baking, and finally to a degassing process. (FR)

1881 HEAT EXCHANGERS FOR HIGH-TEMPERATURE GAS COOLED REACTORS. Okamoto, Y.; Shimomura, H.; Hishida, M. (Japan Atomic Energy Research Inst., Tokai). Kinzoku Zairyo; 13: No. 5, 75-82(May 1973). (In Japanese).

High-temperature gas cooled reactors, because of the possibility of obtaining high temperature gas over 1000°C, can be multi-purpose, such as power generation, iron making, and chemical processing. Heat exchangers for the coolant temperature of about 800°C are described considering design, structural materials, and construction. Due to particular circumstances such as radiation, peculiar conditions have to be met. As the structural materials, super heat-resistant alloys recently developed are used. The construction of the heat exchangers is mainly governed by the materials used. Currently, the heat exchangers are principally helium to water type, of which an example is seen in the Fort St. Vrain reactor. (auth)

1882 GAS CIRCULATORS FOR GAS-COOLED REACTORS. Teruya, H. (Ebara Mfg. Co. Ltd., Tokyo). Ebara Jiho; No. 85, 44-53(Nov 1973). (In Japanese).

With the recent tendency of large size, high temperature, and high pressure of the reactor, the gas circulator requires higher safety and reliability as well as higher pressure, larger capacity, and larger power output than before. Because of these requirements, gas circulators are being developed, tested for substantiation, and put into practice in the U.S.A., U.K., and other leading countries. These circulators can be classified into the circulator with shaft seal and the submerged circulator. The former is the main stream in the U.S.A., and the latter in U.K. (auth)

1883 ASSESSMENT OF TWO FUEL CYCLES FOR HIGH TEMPERATURE GAS-COOLED REACTORS. Nakano, M. (Fuji Electric Co. Ltd., Tokyo). FAPIG (Tokyo); No. 66, 90-96(Aug 1972). (In Japanese).

The highly enriched uranium-thorium cycle and slightly enriched uranium cycle for high temperature gas-cooled reactors were compared with each other. The highly enriched uranium-thorium fuel of the Fort Saint Vrain reactor representative of the high temperature gas-cooled reactors in the United States is a type of hexagonal prism. TRISO type coated fuel particles are used. If power density of the 1000 MW(e) Fort Saint Vrain reactor increases from 6 W/cc to 8 W/cc, fuel cycle costs decrease about 0.07 mills/kWh. The fuel for a helium gas-cooled reactor in England, Mark III, is dispersed fuel with coated fuel particles of low enriched uranium. The basic method to make the low enriched uranium cycle possible is to bring in heterogeneity. Fuel cycle costs of the low enriched uranium cycle are about 0.3 mills/kWh higher than that of the thorium cycle, under the condition that cost of separation work is $26/kg, U_3O_8 is $8/lb and plutonium value is $9.5/g-fiss. A comparison between the uranium cycle and the thorium cycle in pebble bed type reactors was also performed. Under the hypothesis of $7.0/lb U_3O_8, $28.7/kg separation work, and $16.7/kg thorium ore, both cycles require the same cost. (JA)

1884 PROGRESS ACHIEVED IN DESIGN AND CONSTRUCTION. Report to Session 3. Gott, H. H. London; British Nuclear Forum (1973). 8p.

From 5th Foratom congress on nuclear power plant in Europe: yesterday, today, tomorrow; Florence, Italy (14 Oct 1973).

Progress achieved in the design of British nuclear power stations is considered from the point of view of management and organization. Problems relating to siting and the impact of change such as the use of concrete pressure vessels are discussed. Excessive competition within the Consortia system, lack of a strong commercial position, and the change from small prototypes to large to full-scale development of power reactors such as AGRs, are some of the other problems examined. Experience in the technique of project management developed for nuclear stations is described. (UK)

1885 EXPERIENCE ACQUIRED IN THE DESIGN AND CONSTRUCTION OF OPERATING PLANTS. Report to Session 1. Price, E. M.; Bottrell, C.; MaCrae, W. London; British Nuclear Forum (1973). 14p.

From 5th Foratom congress on nuclear power plant in Europe: yesterday, today, tomorrow; Florence, Italy (14 Oct 1973).

The background to the choice of nuclear power in the United Kingdom is summarized. There is discussion on the types of contract for nuclear power plant orders, the construction timescale for the Magnox stations and design modifications to these stations resulting from graphite data changes, noise and vibration in gas circulators, degradation of insulation of vessel liners, and steel oxidation. The transfer of knowledge from R&D organizations to industry and the changing structure of the nuclear industry over the last 20 years are described. Costs for construction, generation, and fuel are discussed. Modifications during design and construction of the Magnox stations to take account of changes in technology, improvements in commissioning techniques and the effects of inflation are discussed. Many design features of AGR reactors are based on the Magnox stations and operating experiences of the latter are summarized. Reference is made to the application outside the nuclear field of techniques developed in nuclear engineering. (UK)

1886 EXPERIENCE OF COMMERCIAL OPERATION. Report to Session 2. Prior, W. J. London; British Nuclear Forum (1973). 9p.

From 5th Foratom congress on nuclear power plant in Europe: yesterday, today, tomorrow; Florence, Italy (14 Oct 1973).

Two major developments since the building of first nuclear power stations in the UK were the introduction of on-load refuelling and of concrete pressure vessels. Tables are presented showing commissioning dates, staff employed and basic technical data for the nine Magnox stations. Statistics of plant performance from 1962 to 1972 are presented: they show output, cumulative performance, and average output during periods of maximum winter demand. Availability charts are shown for both reactors at each station. They include planned and forced outages, the latter for both internal and external causes. Major causes of loss of availability are discussed. Fuel failures, totalling only 0.1% for the 1,200,000 elements manufactured during 1962 to 1972, are tabulated for each station together with the number discharged from each station. Figures are quoted for the average discharge irradiations resulting from fuel element irradiation experiments during the 10 year period and improvements resulting from the assessments from post-irradiation examination are summarized. The discovery of accelerated steel corrosion resulted in a modification to the origi-

nal safety standards for the Magnox stations, by fitting an additional diverse shut-down system. Basic criteria for governing the discharge of radioactive material to the environment and the implementation of these, the discharge of cooling water and procedures to be adopted before siting a new station, are other topics briefly discussed. (UK)

1887 DESIGN OF IODINE TRAPPING PLANTS IN THE UK FOR CEGB GAS-COOLED REACTOR USE. Passant, F. H. (Central Electricity Generating Board, Cheltenham, Eng.). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The design principles and practice for iodine adsorption plants used on CO_2 cooled reactors are described. In general, a single adsorption bed has been provided on Magnox reactor stations through which the reactor coolant can be discharged to atmosphere following the unlikely event of a major release of fission products into the reactor circuit. The AGR stations under construction employ several adsorption beds for routine discharge of reactor coolant, charge/discharge machine coolant and fuel handling cells coolant in addition to an emergency use adsorption bed. The adsorption beds, all utilizing impregnated activated charcoal, have been improved in design over the years to accommodate more stringent requirements for performance, reliability and ease of maintenance. Descriptions are given of current designs including provisions for testing and servicing and the provision of pre- and post filtration in conjunction with the adsorption beds. Incorporation of iodine adsorption beds into ventilation systems associated with CEGE nuclear power stations has not so far been necessary but the design of such beds is under consideration for possible future use on AGRs. A brief description of the type of bed likely to be employed is given. (GE)

1888 NUCLEAR REACTOR. King, L. D. P. (to United States Atomic Energy Commission). German (FRG) Patent 1,439,843. 19 Apr 1973. 5p. (In German).

The described reactor contains a graphite core surrounded by a graphite reflector. The core contains a fissionable material, has a hollow cylindrical shape and has a surface temperature of over 2,000°C. The surface temperature of the concentrically surrounding reflector is kept at a temperature of at least 1,000°C below the surface temperature of the core. The reactor is to be used as a radiation reactor and thus contains a heat exchanger in the reflector and in the between layer. An inert gas continually circulates in the space between the heat exchanger and the graphite core. In addition, a further heat exchanger has been inserted in the hollow of the graphite cylinder concentric to it. (GE)

1889 STABILITY AND CONTROL OF THE SPATIAL POWER DISTRIBUTION IN LARGE HTR CORES. Lauer, A. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 22: No. 3, 184-192(Dec 1973). (In German).

A survey of the status of the problems of xenon-induced spatial flux instabilities with very high-temperature reactors is given and some of the essential results of the xenon investigations carried out in Juelich in the past years are presented. Practical aspects of these phenomena are considered and future tasks remaining in this area are briefly indicated. (GE)

1890 OPTIMAL GAS MIXTURES AS WORKING AGENT IN NUCLEAR GAS TURBINES. Bammert, K. (Technische Univ., Hanover); Klein, R. Atomkernenergie; 22: No. 4, 220-225(1974).

Studies were made on the composition of an optimal working medium for closed-cycle gas turbines. These studies are based on the assumption that this aim could be achieved by mixing helium with a gas of higher molecular weight, using neon, nitrogen, and carbon dioxide. The influence of these gas mixtures on the circuit parameters and on the layout of the turbomachines and heat-exchanging apparatus is shown. The calculations have been carried out giving consideration to the gas behavior of the gas mixtures. In addition to this, the relationship of the costs of the turbomachinery and apparatus are shown in relation to a reference plant with pure helium as the working agent. The basis for these studies is a process with the thermal efficiency, the upper and lower process temperatures and the turbine inlet pressure being the same for all gas mixtures. The results of the calculations are that for certain gas compositions cost advantages can be gained relative to the layout with pure helium. These advantages and the mixture compositions, for which they appear, are dependent on the admixed gases. For these calculations the cost relationship of turbomachines and heat exchangers to the total costs have been considered. (GE)

1891 NUCLEAR STEAM RAISING PLANT. Whitehouse, P. R. (Clarke, Chapman, and Co., Ltd., Gateshead, Eng.); Chambon, P. Kerntechnik; 16: No. 1, 18-22(Jan 1974).

A brief survey is presented of the nuclear boiler design work carried out in the U. K. A brief history is given of the gas-cooled reactors from the early magnox stations to the present AGR stations and, in preparation, for the future high-temperature reactors. The broad technical problems in the area of heat transfer and fluid flow, and some of the specific difficulties that have been tackled on material behavior are described. Some of the special equipment required for maintenance has also been included. (GE)

1892 EXPERIENCE AT WINDSCALE OF FULL SCALE IODINE SORPTION PLANT TESTING WITH METHYL IODINE. Hillary, J. J.; Taylor, L. R. (United Kingdom Atomic Energy Agency, Windscale, Ger.). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Since 1965 the charcoal bed units of the iodine sorption plants at Windscale have been tested with a realistic compound of fission product iodine, methyl iodide-131. These plants have included a range of design features and have been installed to perform a variety of duties, namely the control of reactor coolant gas discharge, leakage and hot cell ventilation. This full-scale test experience, combined with supporting laboratory tests on the sorption material (principally impregnated charcoal) also using methyl iodide-131, has sometimes revealed deficiencies in the plant performance. Problems of mechanical by-passing of the charcoal and in one case extensive poisoning have been observed. Rectification measures and further testing were required to prove the satisfactory performance of the plant. The tests have been conducted with milli-curie levels of ^{131}I activity without causing safety problems; proper test safety procedures must be compiled and strictly adhered to. It is concluded that it is essential to carry out full-scale and laboratory testing of iodine sorption plant in order to give confidence in operational performance. Efficient operation also requires careful attention to design specification, which has been improved during the test program, and to supervision during plant installation. (GE)

1893 EXPERIENCE IN TESTING IODINE SORPTION PLANTS ASSOCIATED WITH CEGB GAS-COOLED REACTORS. Stead, M. (Central Electricity Generating Board, London). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Each of the CEGB's eight nuclear power stations currently operating in the U. K. has an adsorption plant through which the reactor coolant can be discharged in the event of a major release of fission products into the reactor circuit. The adsorption plant consists of a bed of impregnated activated charcoal together with pre and post filters and is designed to remove particulate fission products and all forms of iodine with good efficiency. In-situ tests of the plants revealed weaknesses in design of the charcoal beds which resulted in low efficiency for iodine removal. Remedial work was carried out and the efficiencies are improved. A program of periodic testing and refurbishing of the Board's plants is being established and is discussed. (GE)

1894 IODINE TRAPPING PLANT TESTING AT THE NUCLEAR POWER STATIONS OF EDF. Gence, M. (Electricite de France, Saint Denis). (1973). vp. (In French).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Off-gas systems in nuclear power stations are presently fitted with iodine traps making use of non-impregnated activated charcoal. This equipment is quite satisfactory for retention of molecular iodine but as recent experience tends to prove that most iodine present is to be found in the form of organic iodides, there are plans to replace the charcoal with new charges impregnated with potassium iodide (KI). Owing to loss of efficiency with time, periodic controls are necessary. These can either be carried out in-situ on the entire unit or in the laboratory by quantitative analysis of a charcoal sample taken from the charcoal bed or from a reference trap connected in parallel. The controls carried out in nuclear power stations are based on both of these methods; in-place testing allows the entire trap (charcoal and filters, etc...) to be tested under normal operating conditions. Results obtained show that filtering efficiency decreases with time, though charcoal ageing is not always the only factor responsible. The off-gas systems used are fitted with permanent intake orifices. These must respond to specific conditions if representative results are to be obtained. It has not always been possible to combine all of these in current designs of ventilation systems, where the controls must include the filters and prefilters connected to the trap and where the straight sections are not long enough to ensure proper homogenization of the trace. These test requirements should therefore be borne in mind at the design stage of the installation. (GE)

1895 DEPOSITION AND DESORPTION OF IODINE IN GRAPHITE GAS-COOLED REACTORS. Sigli, P. (CEN, Fontenay-aux-

Roses, France); Benezech, G.; Miribel, J.; Barbier, J.; Cadet, B. (1973). vp. (In French).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Operational monitoring in the six gas-cooled graphite-moderated reactors used by EDF has suggested that iodine plate-out might be occurring in internal structures. To confirm this theory, an experiment was carried out in the CHINON-1 reactor. Radioactive iodine was injected into the primary circuit and the changes in its concentration and physical and chemical nature were studied. Results showed that transformation of molecular iodine into a penetrating form was very rapid. High rates of deposition on internal structures were observed. The desorption process was slow. (GE)

1896 IODINE DISTRIBUTION IN THE DIFFERENT SECTORS OF A GRAPHITE GAS-COOLED REACTOR AND ITS ENVIRONMENT. Barbier, J. (Electricite de France, Saint Denis). (1973). vp. (In French).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

As a fission product ^{131}I forms part of a chain linking tin, antimony, ^{131}Te and ^{131m}Te. The distribution of iodine in the various sectors of the plant, namely fuel, carbon dioxide, walls and environment, depends very largely on the behavior of ^{131}Te and ^{131m}Te. Two experiments prove that almost all the iodine found in the environment comes from tellurium. To demonstrate this theory conclusively it would be necessary to show that tellurium exists in a still more penetrating form than that observed for iodine. If this is so, environmental protection against iodine contamination using special iodine trapping techniques is inadequate; one should think of increasing their effectiveness so as to filter out tellurium. (GE)

1897 BEHAVIOR OF IODINE SPECIES IN THE WINDSCALE AGR. Hillary, J. J. (United Kingdom Atomic Energy Authority, Windscale, Eng.). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

^{131}I has been released into the coolant of WAGR from a number of deliberately or operationally defective fuel pins. This iodine has been found principally in the form of methyl iodide, and based on the majority of the results, has a chemical decomposition half-life, due to plate-out during passage round the gas circuit, of about 2 ½ min. Methyl iodide which was injected separately into the circulating coolant was found to have a similar half-life. The ratio of the steady state ^{131}I release from the fuel to that remaining gas borne was found to be 4,500. The deposition of iodine has been observed on the cooler surfaces of the heat exchangers. The deposition velocity, corresponding to a 2 ½ min half-life, for these heat exchanger surfaces was 0.02 cm/sec. (GE)

1898 HIGH-TEMPERATURE GAS-COOLED REACTOR DEVELOPMENT OUTSIDE THE UNITED STATES: A CONSULTANT'S VIEW. Page, R. W.; Read, D. T. (Burns and Roe, Inc., London). Proc. Amer. Power Conf.; 35: 133-140(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The development of the HTGR-type reactors in Europe and Japan and the organizations that have participated with the HTR development are described. The HTR concept is being developed in West Germany at Julich using spherical fuel elements in the pebble bed reactor. It is projected that a HTR will not be operational in the United Kingdom until 1980-1981. A change in policy in 1969 in France now shows interest for the LWR. Interest by the iron and steel industry in Japan centers on the HTR as an industrial heat source. The initial development of the HTR may be regarded as having been achieved with the Dragon, AVR, and Peach Bottom reactors. (MCW)

1899 HIGH-TEMPERATURE GAS-COOLED REACTOR DEVELOPMENT OUTSIDE THE UNITED STATES: A MANUFACTURER'S VIEW. Schwartz, A. S. (Gulf Energy and Environmental Systems, Inc., San Diego, CA); Goodjohn, A. J.; Fischer, P. U. Proc. Amer. Power Conf.; 35: 141-147(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The advancement of the HTGR-type reactors owes its success to the German AVR, Euratom Dragon, and Peach Bottom projects. The first commercial HTGR (Fort St. Vrain) was built in the U. S. and simultaneously the large gas-cooled reactors of the Magnox and AGR types were being constructed in Europe. The HTGR's with their higher temperatures, greater efficiency, and ability to use thorium, are important from environmental (less heat discharged to environment) and fuel conservation aspects. Their potential lies in the process heat area and for direct-cycle use with gas turbines. (MCW)

1900 CURRENT STATUS OF FORT VT. VRAIN STARTUP PROGRAM. Swart, F. E. (Public Service Co. of Colorado, Platteville); Phelps, R. D. Proc. Amer. Power Conf.; 35: 264-277(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

Fort St. Vrain is a nuclear powered electrical generating station located near Denver, Colorado, employing a HTGR using helium as the primary coolant. Fort St. Vrain will produce a net output of 330-MW(e), using a conventional tandem-compound steam turbine that operates at 3600 r/min, with 2400 psig, 1000°F steam at turbine throttle and with reheat to 1000°F. A total of 64 preoperation tests were prepared to assist in the start-up of the individual plant systems. As of March 1, 1973, 17 reactor plant tests were complete, and 4 were 80 percent complete. For the conventional systems, 21 tests were complete and three were 80 percent complete. The testing procedures are described. (MCW)

1901 COOLING OF NUCLEAR POWER STATIONS FITTED WITH HIGH-TEMPERATURE REACTOR AND HELIUM-TURBINE CYCLE. Foerster, A. (Kernforschungsanlage, Juelich, Ger.). Brennst.-Waerme-Kraft; 25: No. 11, 426-432(Nov 1973). (In German).

The typical characteristics of the cold end of nuclear power stations with high-temperature reactor and helium turbine cycle are explained. The arrangement is described of the 3 cooling systems (river water, wet cooling, dry cooling), as well as the influence of the lower process temperature on cycle design and net efficiency. For installations with dry-air cooling, considerations for optimizing the plant are shown with respect to lower current production cost and decisive design features of the cold end are given. In a comparison with other nuclear power systems (light-water reactor and high-temperature reactor with steam power plant), especially with dry-air cooling, the net efficiency, the thermal loading, and the cooling requirements of the dry-air cooler, are discussed. (GE)

1902 CONTRIBUTIONS CONCERNING THE SHORT-TIME BEHAVIOR OF HIGH-TEMPERATURE REACTORS WITH SPHERICAL FUEL ELEMENTS. Scharf, J. (Kernforschungsanlage, Juelich, Ger.). (1974). vp. (In German).

From experts meeting of the task groups thermodynamics and fluid dynamics and reactor physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

A computer program (DYNOTTO) is described, which solves the time-dependent neutron diffusion equation in axial direction with a two-group approximation. In doing so, up to ten groups of delayed neutrons can be taken into consideration. Control rod accidents, changes in coolant inlet temperature and mass flow are considered as possible sources of perturbations, and the fuel elements are treated either as two or as three-zone spheres. (GE)

1903 NUCLEAR FUEL FOR HIGH TEMPERATURE GAS-COOLED REACTORS. Lindemer, T. B. (to United States Atomic Energy Commission). US Patent 3,798,123. 19 Mar 1974. Filed Date 16 Mar 1972. 8p.

A method of controlling fuel failure within a nuclear reactor is described by providing a novel fuel particle which maintains a total carbon monoxide and carbon dioxide partial pressure of less than $10^{(8.8-13,800/T\,K.)}$ atmospheres at temperatures above 1350°K. (Official Gazette)

1904 POWER GENERATING SYSTEM. Oakes, E. J. (to Gulf General Atomic Inc.). US Patent 3,798,909. 26 Mar 1974. Filed Date 27 Apr 1970. 8p.

A power generating system incorporating a vapor generator of the so-called uphill boiling type is described having an annular arrangement of heat exchanger tubes and a central duct for passing primary fluid to heat the vapor from a position below the vapor generator to a position above the vapor generator from whence it passes downwardly over the tubes. An additional heat exchange section is located within the central duct and has tubes arranged to extend generally parallel with the direction of flow of the primary fluid through such duct. The further heat exchange section is operated as a reheater or a resuperheater. (Official Gazette)

Power Reactors, Non-Breeding, Otherwise Moderated

Refer also to abstract 2080.

1905 (INIS-mf-928) EFFECT OF COMMON MODE FAILURES OF INSTRUMENTS ON RAPS PARAMETERS. Chamany,

B. F.; Gangwal, D. K.; Murty, L. G. K.; Ray, R. N. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 7p. INIS.

From symposium on nuclear science and engineering; Bombay, India (13 Mar 1973).

Redundancy is built in reactor safety systems for protection against random failure of instruments, control components etc. However, protection against random failures does not necessarily guarantee immunity to failures arising from common-mode failures like (1) use of equipment for instrument with common defect, (2) erroneous calibration of redundant channels by maintenance technicians and (3) the limitation in predicting changes in a plant parameter used for safety or control following a postulated incident. Common mode of failures of various instruments used in the Rajasthan Atomic Power Station (RAPS) and their effect on the plant parameters under various postulated incidents have been analyzed. The results are presented to demonstrate the effect of common-mode failure of one set of identical instruments like boiler pressure controller. The functional diversity provided in the reactor protective system restricts the transients to primary coolant temperature and pressure within reasonable limits, whereas severe transients are observed in the secondary side. Secondary steam pressure overshoots to 1026 psia with a tendency to build up further, whereas the maximum operating pressure is 705 psia for the boiler. (INIS)

1906 ROLLED JOINT FOR REACTOR PRESSURE TUBES. Honda, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo); Shibato, E. Doryokuro Giho; No. 6, 46-54(Dec 1972). (In Japanese).

The most important component in the reactor pressure vessel of ATR "Fugen" being developed in Japan is the pressure tube. Because of their special structural material, Zr–Nb alloy, ordinary welding is impossible to join them to stainless-steel primary cooling system. The rolled joint developed for this purpose and its procedure of development and test performed are described. The rolled joint prepared for the pressure tubes is highly pressure-resistant, and tightness condition of 1×10^{-3} acc/sec He leak is fully met; it is well maintained even after tensile and bending tests as well as thermal cycle test. Mechanical strength of the rolled joint is also sufficiently high. (JA)

1907 COMPLEX TESTING OF NUCLEAR POWER PLANT A-1. Kozak, M.; Bosansky, M.; Hezoucky, F. (Atomova Elektraren, Jaslovske Bohunice, Czech.). Jad. Energ.; 19: No. 10, 329-332(Oct 1973). (In Czech).

The testing of the equipment of the A-1 nuclear power plant during start-up is described. The testing was discontinued because of the ejection of oil in the primary loop and because of the necessity of reconstructing some units. After elimination of the oil and reconstruction of the equipment the tests were resumed. The basic data on the start-up are described. (tr-auth)

1908 STEAM GENERATORS AND THEIR ACCESSORIES FOR FIRST CZECHOSLOVAK ATOMIC POWER STATION. Kafka, F.; Rybnicek, J.; Motejl, V.; Jung, J. Jad. Energ.; 19: No. 10, 332-335(Oct 1973). (In Czech).

The steam generators for the first Czechoslovak nuclear power plant were prototypes manufactured according to Czechoslovak patents. A review is given of the problems solved from the initial design to the start-up of the power plant. All tests made and the initial operations during the first stages of start-up confirm the results of the experimental studies. (tr-auth)

1909 DEVELOPMENT AND CONSTRUCTION PROBLEMS OF AUXILIARY SYSTEMS OF NUCLEAR REACTOR A-1. Buchnicek, P. (Vyzkumny Ustav Chemickych Zarizeni, Brno); Kubecek, L.; Svoboda, F. Jad. Energ.; 19: No. 10, 335-339(Oct 1973). (In Czech).

Some problems in the design and construction of the auxiliary systems of the A-1 reactor are briefly described. The difficulties found in the solution of construction problems of the auxiliary systems are compared with those of the primary systems. (tr-auth)

1910 INFLUENCE OF THE REALIZATION OF THE A-1 NUCLEAR POWER PLANT ON THE PIPING AND VALVE BRANCH. Kaisler, L. Jad. Energ.; 19: No. 10, 340-342(Oct 1973). (In Czech).

The construction of the first Czechoslovakian nuclear power plant affected substantially the technical levels of the piping and valve industry. The specifications imposed and the principal results obtained in the manufacture of piping and valves for the reactor are summarized. An evaluation is made of the technical level achieved by the industry. (tr-auth)

1911 TESTS OF THE AUTOMATIC EQUIPMENT IN THE COOLING AND HOUSE POWER SYSTEMS OF THE A-1 NUCLEAR POWER PLANT. Vitazek, L. (Atomova Elektraren, Jaslovske Bohunice, Czech.). Jad. Energ.; 19: No. 10, 343-345(Oct 1973). (In Czech).

An essential part of the testing of a reactor is the tests on the cooling system of the reactor and on the system guaranteeing onsite power for the reactor. The initial cooling regime is initiated by the release of safety rods from the reactor shield. The testing of the emergency or onsite power system is also described. (tr-auth)

1912 END CAPS FOR NUCLEAR FUEL ELEMENTS. Tarasuk, W. R.; Metheral, J. F. (to Canadian General Electric Co. Ltd.). Canadian Patent 917,828. 26 Dec 1972.

End caps for fuel sheaths of the Canadian type are conical to allow for swelling of the fuel, the apex pointing either inwards or outwards. Formerly they were machined from bar stock, but according to the present invention they are stamped from sheet. The conical caps are welded or brazed to the tubes. The caps may also be welded or brazed to the end plate of a fuel bundle. The caps are preferably made from alloy sheet that has the grain structure oriented parallel to the surface. There are advantages in asymmetric conical caps with their apices offset from the axes of the tubes. The outer fuel elements of a bundle may be made with caps that project outwards to engage the latch of a refuelling machine. (CA)

1913 REACTOR PRESSURE CONTROL SYSTEM. Klingbeil, H. N.; Cliffe, W. W.; Ella, R. E.; Castell, W. A. (to Canadian General Electric Co. Ltd.). Canadian Patent 905,569. 18 Jul 1972.

The pressure of the primary coolant in a pressure-tube reactor is controlled by means of a flash-tank, in which the pressure remains at the vapor pressure corresponding to the coolant's temperature. The pressure in the fuel channels is maintained at a fixed differential above that pressure in one or more of three ways: by means of a hydrostatic head, a heater, or a throttle that produces a dynamic pressure differential. (CA)

1914 FUEL MACHINE FORCE INDICATION. Flemons, R. S.; Janusz, S. A. (to Canadian General Electric Co. Ltd.). Canadian Patent 923,638. 27 Mar 1973.

The instrument described is attached to the ram of a refuelling machine associated with a reactor of the Canadian type. The instrument measures the force exerted, in order to detect when a fuel element is jammed in its channel. A magnetic flux sensor is actuated by a loading spring. (CA)

1915 RELEASE OF FISSION PRODUCTS FROM ZIRCALOY-CLAD UO_2 FUEL AT AROUND 1000°C. Hillary, J. J.; Taylor, J. C. (United Kingdom Atomic Energy Authority, Windscale, Eng.). (1973). vp.

From seminar on filter testing; Karlsruhe, Ger. (4 Dec 1973).

Fission product release experiments were carried out with Zircaloy-clad UO_2 fuel pins including two which were available from an irradiation experiment in SGHWR. The pins were caused to fail in flowing steam at approximately 1,000°C, which are conditions relevant to some SGHWR fault situations, and the escaped fission products Xe-133, I-131, and in some cases Kr-85, were trapped and measured. The results of these experiments are assessed with a view to providing the best present estimates of inert gas/I-131 release ratios for use in reactor incident evaluation. (GE)

1916 OPERATING EXPERIENCE OF THE SGHWR IODINE SORPTION SYSTEM. Clifton, J. J. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). (1973). vp.

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

The design and layout of the SGHWR filter units, the method of testing and the operational test experience and mechanical performance during six years of continuous operation are described. Included is a brief description of the tests carried out on iodine filtration units installed in the extract ventilation system of a "hot cell" facility. (GE)

1917 PICKERING POWER STATION REACTORS AND TURBINE-GENERATORS; DESIGN FEATURES AND INITIAL OPERATING EXPERIENCE. Morison, W. G. (Ontario Hydro, Toronto); Parsons, N. C.; Hawley, R. Proc. Amer. Power Conf.; 35: 237-245(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The Pickering nuclear generating station is located near Toronto. The 2160-MW(e) station, consisting of four identical heavy-water moderated and cooled Candu-type reactors, each coupled to a tandem-type compound turbine-generator was quickly brought to full power and operated at a high capacity factor. On-power refueling with natural uranium oxide fuel was achieved on schedule. The heat source for each unit is a heavy-moderated heavy-water-

moderated, pressurized heavy-water-cooled, natural uranium dioxide-fueled, horizontal pressure tube reactor. The design features of the turbine-generator are described. Unit 1 was completed in Fall, 1970, went critical on Feb. 25, 1971. First electricity was produced April 4, 1971 and full power was achieved in Unit 1 on May 30, 1971. Unit 2 went critical, Sept. 15, 1971 and reached full power Nov. 7, 1971. Unit 3 went critical April 24, 1972, and reached full power May 12, 1972. Unit 4 was scheduled to go critical Feb. 1, 1973. Inspection results in Unit 1 are superior. (MCW)

1918 DECONTAMINATION BY CYCLING TECHNIQUES AT THE DOUGLAS POINT NUCLEAR GENERATING STATION. Montford, B. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Proc. Amer. Power Conf.; 35: 902-914(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

A cycling decontamination is a combination of temperature, hydraulic, and redox cycles. The techniques were developed from a series of 14 cycling decontaminations in the period Oct. 1971 to April 1972. The recommended procedure is outlined and the approach could be applied to all reactors. The cycling decontamination techniques during the 14 reactor outages, removed 500 to 800 Curies of ^{60}Co, and reduced the boiler radiation fields by 85 percent. (MCW)

1919 ENGINEERING IMPLICATIONS OF IRRADIATION ON SGHWR CORE MATERIALS. Bradley, N. (Nuclear Power Group Ltd., Risley, Eng.). pp 23-26 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The SGHWR is a pressure tube reactor using light water as the coolant and heavy water as the moderator. The fuel is enriched uranium oxide clad in zirconium alloy. The components of the reactor which are subject to irradiation are all confined within the neutron shield vessels, these in turn being supported from a concrete structure. Radiation and combined radiation corrosion effects are considered under the following headings: neutron shields (ferritic steel components), Zircaloy pressure tubes, zirconium/steel joint (the zirconium alloy tube is joined to the cooling circuit by expanding into a 12% chrome steel hub), CO_2 blanket around neutron shields and between calandria and pressure tubes to avoid corrosion due to nitric acid formed by chemical effects of radiation on traces of water vapor and nitrogen. (UK)

1920 CONSTRUCTION OF A FULL-SCALE MODEL OF A NUCLEAR VESSEL TUBULAR ELEMENT. Hennion, J.; Binard, J. (Societe Babcock-Atlantique, Saint-Nazaire, France). Soudage Tech. Connexes; 27: No. 11, 447-453(Nov 1973). (In French).

A model was fabricated of the tubular element of a nuclear vessel. It consists of two 2m diameter plates and twenty-one 220mm diameter tubes. Two machines were used in the construction: electron beam welding equipment (with vacuum suction cups for welding circular seams between the tubes and plates) and a machine using ultrasound for automatically inspecting the welded seams. The inspection carried out indicates the suitability of the method for constructing the tubular elements of nuclear vessels with the advantage of considerably reduced price and the avoiding of machine shop delays. (FR)

1921 FIRST CZECHOSLOVAKIAN ATOMIC POWER PLANT A-1 WITH HEAVY-WATER GAS COOLED REACTOR (DEVELOPMENT AND DESIGN). Abramov, V. M.; Baturov, B. B.; Bogdanov, N. B. At. Energ. (USSR); 36: No. 2, 113-124(Feb 1974). (In Russian).

The first Czechoslovakian atomic power plant A-1, the heavy water gas-cooling reactor KS-150 mounted on it, and the metallic uranium wire are briefly described. Some data on designing and construction are also given. The advantages of this type of reactor are considered. (14 references) (auth)

Power Reactors, Breeding

Refer also to abstracts 249, 783, 789, 790, 953, 1993, 2068, 2072, 2085, 2086, 2091, 2099, 2144, and 2172.

1922 (AI-AEC-12995) 1000-Mwe LMFBR EMERGENCY SHUTDOWN SYSTEM STUDY: LITERATURE SEARCH ON EMERGENCY SHUTDOWN SYSTEM CONCEPTS. Zwetzig, G. B. (Atomics International Div., Canoga Park, Calif. (USA)). 9 Feb 1972. Contract ANL 31-109-38-2436. 59p. Dep. NTIS $6.00.

Twenty-three basic concepts for emergency shutdown systems, as obtained from the literature, are described. Experimental data on potential control materials are reviewed. Reports describing control system failures and control system testing are referenced. 45 references. (auth)

1923 (ANL-7952) SENSITIVITY STUDY FOR FAST-REACTOR DISASSEMBLY CALCULATIONS. Nicholson, R. B.; Jackson, J. F. (Argonne National Lab., Ill. (USA)). Jan 1974. Contract W-31-109-eng-38. 70p. AT.

An investigation of the sensitivity of LMFBR disassembly calculations to variations in the pertinent parameters and initial conditions is presented. The variations were made about two hypothetical excursions on an FFTF reactor model. The situation in which the coolant is fully voided from the core is studied first. Next, the effect of having sodium present during disassembly is discussed. Possible implosive effects that result from nonuniform voiding are examined. The results are used to evaluate the accuracy of the disassembly calculations and pinpoint areas in which further improvements in methods and parameters would be of greatest benefit. 13 references. (auth)

1924 (ANL-8031) MULTIPURPOSE SODIUM SAMPLER FOR LMFBR's: DESIGN AND OPERATION. Kolba, V. M.; Holmes, J. T.; Skladzien, S. B.; Slawecki, M. A.; Filewicz, E. C.; Nelson, P. A. (Argonne National Lab., Ill. (USA)). Feb 1974. Contract W-31-109-eng-38. 53p. AT.

A multipurpose sampler (MS) has been designed and developed for use on liquid-metal systems, including liquid-metal-cooled fast-breeder nuclear reactors. With the MS, the plant operating crew is capable of performing all of the sampling functions required for the monitoring of impurities in liquid-metal systems. These functions are as follows: (1) obtaining overflow-type cup samples, including samples that are protected from the atmosphere by frozen-metal seals; (2) high-temperature (1382°F) equilibration of the impurities (O, C, H, N) in the liquid metal with appropriate solid-metal specimens (the specimens are removed and easily analyzed chemically for the impurity elements, and, by using known distribution coefficients, the activities of the impurity elements in the liquid metal can be obtained); and (3) filtration sampling for particulate material in the liquid-metal systems. The MS was designed to fit the minimal space that had been allotted for the installation of the sampler in the primary sodium-sampling cell of the Fast Flux Test Facility (FFTF). Prototype units were fabricated and have been tested on small laboratory loops at Argonne National Laboratory (ANL) and Hanford Engineering Development Laboratory (HEDL). Sampler-component operation and overall system operation have been successfully demonstrated. 6 references. (auth)

1925 (ANL-8065) NONLINEAR DYNAMIC RESPONSE OF REACTOR-CORE SUBASSEMBLIES. Kennedy, J. M. (Argonne National Lab., Ill. (USA)). Jan 1974. Contract W-31-109-eng-38. 48p. Dep. NTIS $4.00.

An approach is described for calculating the two-dimensional structural response of an accident occurring in a single-core subassembly and possibly propagating to the adjacent one or two rows of subassemblies. A finite-element method is used for this transient, nonlinear dynamic analysis of large-displacement, small-strain problems with material nonlinearities. The method employs a convected-coordinate technique and a direct nodal-force computational scheme, which consequently results in considerable efficiency. The developed set of the basic equations is programmed for solution on the IBM-360 computer. Node displacements, strains and stresses at various levels through the nodal-section thickness, volume change of a structural segment, and pressure change of a particular pressure line are given at any instant of time. 15 references. (auth)

1926 (ANL-CT-74-12) POSSIBILITY OF ELECTROMAGNETIC SELF-EXCITATION IN THE LIQUID METAL FAST BREEDER REACTOR. Pierson, E. S. (Argonne National Lab., Ill. (USA)). Apr 1974. 25p. AT.

The general problem of self excitation in the LMFBR is discussed. The details of the flow are used to find the relevant SE condition. Also, use is made of the theorem that a SE condition cannot exist with an axisymmetric flow and magnetic field. Most of the attention is confined to the flow in the reactor core cooling ducts. A few simple flow patterns in the reactor core are analyzed and some numbers obtained. The models used to obtain these numbers are such that the numbers are on the high side, so that if SE is predicted not to occur this is a conservative prediction. A prototype LMFBR core geometry using spiral wire wrapped fuel pins is defined. The helical flow in each channel in the core consists of a parallel component and a rotating component, so that three types of interactions between channels are possible. The parallel flow interactions, rotating flow interactions, and parallel to rotating flow interactions are considered. A brief discussion of centrifugal pumps is presented. (5 references) (auth)

1927 (ANL/EBR-81) PROGRAMS FOR DATA MANIPULATION AND ANALYSIS ON THE EBR-II SIGMA 5 COMPUTER. Larson, H. A. (Argonne National Lab., Ill. (USA)). Feb 1974. 49p. Dep. NTIS $5.50.

Mathematical description, input instructions, sample programs, and program listings for data-manipulation and data-analysis computer programs specifically designed for use as analysis aids with the EBR-II Sigma 5 computer system are presented. Though not completely general and all-encompassing, this document may serve as a user's manual for EBR-II personnel. Included are digital filters, simple integration and interpolation schemes, frequency-domain-analysis schemes, and a generator for pseudorandom binary signals. (21 references) (auth)

1928 (CONF-740401-11) SAFETY RELATED CRITERIA AND DESIGN FEATURES IN THE CLINCH RIVER BREEDER REACTOR PLANT. Strawbridge, L. E. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1973. Contract AT(11-1)-2395. 30p. Dep. NTIS $4.50.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

The Clinch River Breeder Reactor Plant (CRBRP) is in the preliminary design phase. A site on the Clinch River in Tennessee has been selected for this demonstration plant. The preliminary design is based on guidelines specified by Project Management Corporation at the initiation of the project. The guidelines include requirements for reliability, safety and ready licensing capability. The overall design approach to assure safe operation and the development of safety related design bases are described. The overall design approach includes three levels of design that provide defense in depth. The first level provides a technically sound design that results in high reliability and minimizes the occurrence of accidents. The second level provides protection against failures or misoperations which might occur in spite of precautions taken in the design, construction and operation of the plant. The third level provides margin in the plant design as additional assurance that protection to the public is provided even in the event of extremely unlikely and unforeseen circumstances. The safety related design features that have resulted from applying the three levels of design approach are described and areas in which design flexibility has been retained are indicated. (5 references) (auth)

1929 (HEDL-SA-622) SODIUM FIRE PROTECTION BY SPACE ISOLATION WITH INERT GAS FLOODING. Hilliard, R. K.; McPherson, P. E.; Yatabe, J. M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1974. Contract AT(45-1)-2170. 15p. (CONF-740401-5). Dep. NTIS $4.00.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

The concept of sodium fire protection by space isolation with inert gas flooding is described and the requirements for implementation in a LMFBR facility are pointed out. The mechanisms for oxygen inleakage are analyzed and the rate of inert gas injection required to prevent oxygen inleakage is calculated. A large-scale proof test was performed to demonstrate the method under actual fire conditions. The 770 lb sodium spill at 1100°F into a full scale mockup of an FFTF secondary sodium pipeway was effectively controlled and extinguished. Comparisons are made with SOFIRE code predictions. (auth)

1930 (HEDL-SA-630) REACTOR SODIUM COOLANT HYPOTHETICAL SPRAY RELEASE FOR CONTAINMENT ACCIDENT ANALYSIS: COMPARISON OF THEORY WITH EXPERIMENT. Shire, P. R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Apr 1974. Contract AT(45-1)-2170. 16p. (CONF-740401-7). Dep. NTIS $4.00.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

An analytical model of a sodium splash dispersal accident within LMFBR containment is compared with experimental results. The requisite pipe break is an accident of extremely low probability. Cells are filled with inert gas to preclude rapid ignition of sodium; however, the effect of a nominal 1-2% oxygen in the cell atmosphere must be evaluated. This, along with rapid heat transfer from high temperature sodium droplets, produces a fast rising pulse of temperature and pressure in the gas volume. The resulting pressure rise was found to be sensitive to droplet diameter, sodium quantity and sodium temperature as well as oxygen concentration. When values of these parameters are similar to the test data, calculated results agree within statistical accuracy of experimental results to give typical pressure rises of 0.6 psi at 0% oxygen, 0.7 psi at 1% oxygen and 2.5 psi at 5% oxygen. (11 references) (auth)

1931 (HEDL-SA-651) WEAR RESISTANT COATINGS FOR REACTOR COMPONENTS IN LIQUID SODIUM ENVIRONMENTS. Johnson, R. N.; Schrock, S. L.; Whitlow, G. A. (Westinghouse Hanford Co., Richland, Wash. (USA); Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1974. 27p. (CONF-740103-3). Dep. NTIS $4.50.

From conference on structure-property relationships in thick film and bulk coatings; San Francisco, California, USA (28 Jan 1974).

Rubbing surfaces of critical components for the coming generation of the nation's liquid-metal-cooled-fast-breeder reactors must withstand severe environments of high temperature, liquid-metal corrosion, and nuclear irradiation. For several applications, bulk (>25 micron thick) coatings have provided the only successful solution to friction problems in high temperature sodium. Coating processes that have been or are being evaluated include plasma spray, detonation gun, spark-discharge, sputtering, and diffusion coating processes. Testing included friction and wear tests in up to 650°C sodium, sodium corrosion tests for up to one year, thermal cycling, bond strength tests, and irradiation tests in a fast reactor. For one particularly severe application, a specially modified commercial coating of chromium carbide in a 15 volume percent nichrome binder, applied by a commercial detonation gun process, has so far been found to be most acceptable in meeting the friction, corrosion, and irradiation damage criteria. Much of the test data reported is on this coating and its antecedent modifications. (7 references) (auth)

1932 (HEDL-SA-699) LABORATORY STUDIES ON MELTING AND GAS RELEASE BEHAVIOR OF IRRADIATED FUEL. Weber, E. T.; Slagle, O. D.; Hinman, C. A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1974. Contract AT(45-1)-2170. 23p. (CONF-740401-12). Dep. NTIS $4.25.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

The response of irradiated fuels to rapid heating is a major factor which must be considered in safety analyses for fast reactors. A series of experiments at HEDL provide observations and data on the response of fast flux (EBR-II) irradiated fuel materials when subjected to rapid heating in the laboratory. Fuel samples within a resistively heated tungsten tube are subjected to thermal transients in a system providing for temperature and pressure measurements, in addition to continuous gamma radiography of the sample. Results of heating fuel at rates of 50° to 250°C/sec. are presented. Unirradiated UO_2 slumps rapidly when melted. Lower power irradiated fuel with uniform fission gas distribution was observed to break apart below the melting point, resulting in dispersal from the effect of released fission gas. Extensive gas bubble formation occurs below the solidus and bubble expansion results in a foam-like structure at the melting temperature. High power irradiated fuel behaves differently, consistent with the relative gas distribution and content. Less fuel motion is observed; the major effect of fission gas is to slow downward displacement upon melting. Measurements of the temperature dependence of gas release indicate that gas release begins at fuel temperatures near 2000°C and a significant fraction of the fission gas has been released when fuel reaches the melting temperature. (12 references) (auth)

1933 (KFK-1797) RADIOACTIVE REACTOR INVENTORIES AS A FUNCTION OF TIME BEFORE AND AFTER SHUT-DOWN. Wild, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Angewandte Systemtechnik und Reaktorphysik). Feb 1974. 104p. (In German). Dep. NTIS (U. S. Sales Only) $8.25.

Exact knowledge of the activity inventory of a reactor is a necessary basis for any safety analysis. The carriers of the activity inventory, the radionuclides of four different reactors are considered. These reactors represent two variants each of the light water reactor and the liquid metal fast breeder reactor. The variants again differ in the extent to which the various isotopes composing the fuel contribute to the total power of the reactor. The activity carriers are classified according to the scheme, fuel, fission products, activated structural material and activated coolant. As structural material, the calculations consider all interior structure of the pressure vessel, as coolant the total mass of the primary coolant. The results are presented in table and graph form. They clearly show the fission product activity of a breeder reactor to be somewhat less than of a light water reactor. The reverse is the case for structural material and coolant activity. After time spans in excess of 50 years, the isotopes of plutonium play the dominant role for both types of reactors. Furthermore, the activity of a light water reactor, whose first core consists in part of recycled plutonium, differs from that of the breeder reactor by a factor of only $\frac{1}{2}$ to $\frac{1}{3}$, assuming equal thermal rating of the reactors. (28 references) (auth)

1934 (LMEC-74-1) LIQUID METAL ENGINEERING CENTER (LMEC) ANNUAL TECHNICAL PROGRESS REPORT, JANUARY–

DECEMBER 1973. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 15 Mar 1974. Contract AT(04-3)-700. 502p. AT.

Progress in the testing of FFTF and LMFBR components in a sodium environment is described. The components included steam generators, pump seals, valves, thermal insulation, transducers, and thermocouples. Research on general LMFBR technology included sodium fire suppression studies and heater failure studies. (JWR)

1935 (RDT-E-2-3-T(12-73)) REACTOR VESSEL FOR LIQUID METAL SERVICE. (USAEC Division of Reactor Research and Development, Washington, D. C.). Dec 1973. 28p. RSO.

The requirements are presented for reactor vessels for reactor systems with loop-type sodium cooling that are constructed in accordance with the Class 1 requirements of the ASME Boiler and Pressure Vessel Code, Section III, and supplementary requirements that are additive or more restrictive. (auth)

1936 (RDT-E-4-16-T(2-74)) SODIUM-HEATED STEAM GENERATOR. (USAEC Division of Reactor Research and Development, Washington, D. C.). Feb 1974. 43p. RSO.

The requirements for the design, development testing, material selection, fabrication, shop testing, inspection, shipping, handling, and installation of sodium-heated steam generators are presented. Steam generators designed, built, tested, and inspected in accordance with this standard will meet the requirements of Section III of the ASME Boiler and Pressure Vessel Code (the Code). This standard covers only the heat exchange components (superheater and evaporator). (auth)

1937 (WAPD-TM-1089) MEASUREMENT AND ANALYSIS OF PARAMETERS IN TIGHT $^{232}Th-^{235}U$ AND $^{232}Th-^{233}U$ LATTICES MODERATED WITH D_2O (LWBR DEVELOPMENT PROGRAM). Hardy, J. Jr.; Volpe, J. J.; Klein, D. (Bettis Atomic Power Lab., Pittsburgh, Pa. (USA)). Jan 1974. Contract AT(36-1)-GEN-14. 86p. Dep. NTIS $7.50.

Parameter measurements and calculations in two D_2O-moderated Thorium–Uranium critical assemblies are described in detail. The first, designated ETA-I, contained 6.7 w/o $^{235}UO_2-ThO_2$ fuel rods of 0.260" diameter, clad in aluminum. The second assembly, designated ETA-II, contained 3.0 w/o $^{233}UO_2-ThO_2$ fuel rods of .430" diameter, clad in Zircaloy-2. A relatively hard spectrum was obtained in both lattices. Because leakage was small and the central flux spectra were closely asymptotic, these assemblies provide a cleanly analyzable test of important reaction cross sections. Specific parameters measured in ETA-I were: ^{232}Th fission/^{235}U fission (δ^{28}), ^{232}Th capture ^{235}U fission (CR^*), and epithermal/thermal ratios for ^{235}U fission (δ^{25}) and ^{232}Th capture (ρ^{28}). Corresponding measurements (with U^{233}) were made in ETA-II. Supplemental fast-thermal spectrum comparisons were made between the ETA assemblies and the 4/1 TRX critical assembly by means of activation detectors. The lattices were analyzed explicitly with a full energy range Monte Carlo program having a detailed cross section description. ENDF/B Version 2 and LWBR cross section sets were used. Overall agreement with experiment was very good. (28 references) (auth)

1938 (WAPD-TM-1090) STUDY OF THE ThO_2 DOPPLER EFFECT IN A TIGHT $^{235}UO_2-ThO_2$ LATTICE MODERATED WITH D_2O (LWBR DEVELOPMENT PROGRAM . (Bettis Atomic Power Lab., Pittsburgh, Pa. (USA)). Jan 1974. Contract AT(36-1)-GEN-14. 21p. Dep. NTIS $4.25.

The ThO_2 Doppler coefficient for resonance neutron capture was measured in the hard flux spectrum of the ETA-I assembly, a tight D_2O moderated lattice of 6.7 w/o $^{235}UO_2-ThO_2$ fuel rods. A ThO_2 sample rod of 0.42 cm diameter was irradiated in a small oven inserted into the center of the lattice. Measurements were made between 296°K and 950°K. The experiment was analyzed with the RECAP program, a full energy range Monte Carlo calculation with detailed cross section representation and an explicit geometric description. Cross sections were ENDF/B Version 2 deuterium and oxygen and LWBR ^{232}Th. The measured result was $A(900°K)/A(296°K) = 1.280 \pm .032\ \sigma$. The calculation gave $1.213 \pm .010\ \sigma$, which is 5% below experiment, with an uncertainty of ~2.5%. (5 references) (auth)

1939 (WARD-HT-3045-4) VALIDATION OF HIGH TEMPERATURE DESIGN METHODS AND CRITERIA. Quarterly Progress Report for Period Ending November 30, 1973. Bishop, E. C. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Mar 1974. Contract AT(11-1)-3045. 153p. AT.

The inelastic characteristics of strain tolerances of Type 304 stainless steel structures which represent LMFBR core components and cooling system components are measured. Information on the Multiloading Test Facility heaters is presented. Specifications are presented for the test section of the FFTF reactor intermediate heat exchanger inlet nozzle. (DCC)

1940 (WARD-QX-3045-7) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for Period Ending December 31, 1973. Boltax, A.; Saling, J. H. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Mar 1974. Contract AT(11-1)-3045. 123p. AT.

Progress in the development and testing of stainless steel clad mixed oxide fuel pins for LMFBR reactors is reported. Irradiation tests in EBR-2 are described. Work on the mechanical, thermal, and hydraulic design of grid-type assemblies for the FFTF is reviewed. Studies of radiation effects on Type 304 and Type 316 stainless steels are discussed. The development of the LIFE code for mixed oxide fuel rod performance analysis is reviewed. (DCC)

1941 LIQUID COOLED NUCLEAR REACTOR. Mueller, R. A. (to Gesellschaft fuer Kernforschung mbH). US Patent 3,793,143. 19 Feb 1974. Priority date 21 Mar 1971, F. R. Germany. 8p.

There is disclosed a nuclear reactor that has a reactor tank enclosing a reactor core and a component tank accommodating a coolant pump and a heat exchanger disposed in a shell which is secured gastight to the top wall of the component tank. The coolant is carried by conduits in both directions between the heat exchanger and the reactor core. The space above the coolant level in the component tank externally of the shell communicates by means of a further conduit with the space above the coolant level in the reactor tank. The space above the coolant level in the reactor tank communicates with the space above the coolant level in the shell by means of a pressure equalizing conduit. (Official Gazette)

1942 LOGISTICS OF NUCLEAR FUEL. Golan, S. (Atomics International, Canoga Park, CA); Salmon, R. At. Strom; 19: No. 11/12, 103-109(Nov 1973). (In German).

From meeting of the American Nuclear Society; Washington, DC (19 Nov 1972).

A model of the requirement of electrical energy in the USA up to the year 2000 and different reactor strategies, and the demand for nuclear fuel and for installations for operation of the fuel circuit are discussed. As a basis for different reactor strategies the time of the introduction of the fast breeder is varied. (GE)

1943 SOME PROBLEMS ON DEVELOPMENT OF FAST BREEDER REACTOR. Yamada, T. (Atomic Energy Commission, Tokyo). Genshiryoku Kogyo; 19: No. 6, 9-13; 37(Jun 1973). (In Japanese).

Despite the past 20 odd years efforts by scientists and technologists over the world, fast breeder reactors are not yet in practical use, although the present state seems to be only a step away from it. The current state of FBR development is described including: significance of the development of FBRs, technological aspects in the development, world trends in FBR development, optimization of blankets, and uncertain factors in the fuel cycle. The FBRs are advantageous not only in fuel efficiency and economy, but also in environmental aspects. Controversial aspects are safety, swelling, pot or loop type, etc. Breeding characteristics of the FBRs are closely related to the optimum design of blankets. (auth)

1944 TESTS ON THE CGVS OF THE 45 MW MOCK-UP OF PHENIX STEAM GENERATOR. Beaufrere, J. (Electricite de France, Ecuelles); de Montardy, M.; Lecocq, P.; Llory, M. Bull. Dir. Etud. Rech., Ser. A; No. 1, 201-234(1973). (In French).

Tests were effected on the 45 MW Phenix steam generator mock-up constructed by Stein Industrie on the 50 MW experimental sodium heated steam generator loop (CGVS). The tests were carried out during a period of 13,000 hours, 6,800 of which were under operating power conditions. The specifications and operating conditions of the test facility are recalled. The most important of the thermal test results are compared with results obtained using computer codes developed by Electricite de France (EDF). (FR)

1945 DEVELOPMENT WORK FOR GAS-COOLED FAST BREEDER REACTORS. Dalle Donne, M. (Kernforschungszentrum, Karlsruhe, Ger.). Fridericiana; No. 13, 27-31(Nov 1973). (In German).

The development of gas-cooled fast breeder reactors to date is briefly reviewed, discussing the properties of helium and sodium as cooling agents and, in particular, the advantages and disadvantages of helium. (GE)

1946 CONTROL ROD FOR A HIGH POWER FAST NEUTRON NUCLEAR REACTOR. Dulieu, P.; Pflugrad, K.; Sicard, B.; Skok, J. (to Commissariat a l'Energie Atomique). French Patent 2,162,283. 9 Dec 1971. 11p. (In French).

A control rod for a high power fast neutron reactor is presented, a special feature being that it occupies part of the cross section of a special fuel element having the same total cross section as the other normal fuel elements of the reactor. The part of the special fuel element, which is not occupied by the control rod, is occupied by fuel pins arranged as they would be in a normal reactor fuel element. (FR)

1947 CONTROL ROD FOR A HIGH POWER FAST NEUTRON NUCLEAR REACTOR. Dulieu, P.; Pflugrad, K.; Sicard, B.; Skok, J. (to Commissariat a l'Energie Atomique). French Patent 2,162,284. 9 Dec 1971. 11p. (In French).

A control rod for a high power fast neutron reactor is presented, a special feature being that it occupies part of the height of a special fuel element having the same total height as the other normal fuel elements of the reactor. The part of the special fuel element, which is not occupied by the control rod, is occupied by reduced height fuel pins arranged as they would be in a normal reactor fuel element. The reduced height pins take the place of the control rod when it is raised up in the fissile zone of the reactor core and slide beneath the core when the control rod is lowered. (FR)

1948 DEVICE FOR TRANSFERRING, CHARGING, AND DISCHARGING NUCLEAR REACTOR FUELS. Aubert, M.; Michot, G. (to Commissariat a l'Energie Atomique). French Patent 2,161,754. 28 Oct 1971. 13p. (In French).

A device is presented for the transferring, charging, and discharging of the fuel assemblies of fast neutron reactors. The liquid metal cooled core of the nuclear reactor is contained in a primary vessel which is surrounded by a principal vessel. The device is provided with a mechanism for bringing the assembly above and in line with an opening in the primary vessel, this opening being closed with a removable plug. A recipient, which receives the fuel assembly, is placed at the lowest position beneath this opening. This recipient is moved in liquid metal along an allowed ramp in the space between the primary vessel and the principal vessel. The device is supplied with at least one bearing race and enables the charging and discharging of the recipient containing the assembly to be effected across a slab (which closes the upper part of the principal vessel) by a translatory movement of the recipient. The elbowed ramp is mounted on a plug fixed into the slab wall. (FR)

1949 PREORIENTED GRIPPING DEVICE. (To Commissariat a l'Energie Atomique). French Patent 2,161,822. 2 Dec 1971. 8p. (In French).

A preoriented gripping device for the fuel element of a nuclear reactor is presented. This device is of the type possessing a control cam for the control of the claws of the gripping device, this cam being positioned at the lower end of a vertical rod whose upper end is terminated by a casing constructed of magnetic material. The special features of this device are that it is provided with another vertical rod positioned in the elongation and above the first rod. The upper end of this rod is provided with means for translating the second rod in relation to its axis and means for rotating it about its axis. The lower part of this rod is provided with an electromagnet. (FR)

1950 NUCLEAR FUEL SUBASSEMBLY. Skok, J. (to Commissariat a l'Energie Atomique). US Patent 3,798,125. 19 Mar 1974. Priority date 20 Nov 1970, France. 4p.

A nuclear fuel assembly for a liquid metal cooled fast reactor comprises a bundle of fuel pins in a shroud. Each pin carries a helical spacer fixing the minimum spacing between each pin and the adjacent pins or the shroud. Localized head losses along the lateral subchannels are produced by wires disposed parallel to the inner wall of the shroud and obliquely with respect to the axes of the pins. (Official Gazette)

1951 EQUATIONS OF MOTION OF A LIQUID-SUBMERGED SONIC GAS JET RELATIVE TO FISSION-GAS-JET IMPINGEMENT IN SUBASSEMBLIES OF THE LIQUID METAL FAST BREEDER REACTOR. Chawla, T. C. (Argonne National Lab., IL). Nucl. Sci. Eng.; 53: No. 4, 466-474(Apr 1974).

It is well known that the small-perturbation equations governing steady or mildly unsteady potential flow in a sonic or a transonic gas jet are nonlinear. However, for a liquid-submerged sonic gas jet with a disturbance on the gas–liquid interface, the analysis shows that the unsteadiness introduced into the flow by oscillation of the gas–liquid interface due to presence of Kelvin–Helmholtz instability is sufficiently large, the nonlinear disturbance accumulation does not have time to develop, and the linearized treatment that includes the transient motion of gas becomes valid. Through an order-of-magnitude analysis of the full governing equations for the gas flow in a liquid-submerged axisymmetric sonic gas jet with a disturbance at the gas–liquid interface, the condition under which the governing equations can be linearized is obtained. It is shown that this condition of linearization takes the form of the Weber number $(We) \gg 26\,(\rho/\rho_g)^{0.2}$ for the case of low-viscosity liquids and $We \gg 36\sqrt{\mu U_g/\sigma}$ for the high-viscosity liquids surrounding the gas jet. (U_g is the gas velocity, ρ is density, σ is surface tension, and μ is the dynamic viscosity.) It is demonstrated that most gas–liquid systems of physical interest satisfy the condition of linearization. Examples of application can be found in the field of pneumatic atomization using a sonic gas jet, and in the field of Liquid Metal Fast Breeder Reactor (LMFBR) safety in relation to thermal transients induced by impingement on a fuel pin of a sonic fission-gas jet released from an adjacent breached pin. For the purpose of comparison with a sonic gas jet, it is also shown that in the case of subsonic and supersonic gas jets, the linearization of equations of motion to a first order is generally possible; that is, the condition of linearization for these jets is not as stringent as for the sonic gas jet. When in transient motion due to a disturbance at the gas–liquid interface having wave velocity much smaller than the gas velocity, the transient terms in comparison to perturbation terms of basic flow are of second order. In contrast to these jets, in the case of a sonic gas jet the transient motion of the gas cannot be neglected even at very slow oscillations of the gas–liquid interface. (auth)

1952 FISSION PRODUCT DISTRIBUTION IN FAST REACTOR OXIDE FUELS. Powell, H. J. (Dounreay Experimental Research Establishment, Scotland). pp 379-392 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behavior and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The paper describes results obtained at Dounreay by postirradiation examination of fuel pins irradiated in the Dounreay Fast Reactor (DFR) as part of the PFR fuel development program. (7 figures) (auth)

1953 ANALYSIS OF SOME FAST REACTOR PERTURBATION EXPERIMENTS USING MOLYBDENUM SAMPLES. Beynon, T. D.; Wijeysundera, N. E. (Birmingham Univ., Eng.). Atomkernenergie; 22: No. 4, 251-256(1974).

A comparative study, using collision probability theory and diffusion theory, is made of some recent reactivity perturbation measurements in the Swedish fast critical assembly FRO using samples of ^{95}Mo and ^{97}Mo. The more accurate collision probability approach serves to show that existing neutron cross section data for ^{95}Mo are known with an acceptable degree of accuracy. For the isotope ^{97}Mo the present uncertainties in its cross section data lead to an unacceptable overprediction of its reactivity worth. For both isotopes it is estimated that the largest contribution to the reactivity worths in a LMFBR design would occur at energies above 100 eV. It is recommended that further cross section evaluations be made above this energy. (GE)

1954 FAST BREEDER POWER REACTOR. Jens, W. H.; Edlund, M. C.; Barringer, H. S.; Davidson, J. K.; Klotz, C. E.; Nims, J. B.; Miller, R. S.; Palmer, R. G. (to United States Atomic Energy Commission). German (FRG) Patent 1,514,964. 26 Jul 1973. 11p. (In German).

The described reactor is sodium cooled and has an annular core with an annular breeder zone under the core, as well as an annular breeder zone within the core and surrounding it. The fuel elements consist of fuel rods arranged axially in fuel channels. The largest part of each fuel rod contains fissionable material (fuel part) whereas the lower part of each fuel rod contains breeder material and forms a breeder zone. The fuel element has a hexagonal configuration. The basic design of the reactor is given. (GE)

1955 PRESENT STATUS OF REACTOR DEVELOPMENT. Tomabechi, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 19: No. 6, 14-21(Jun 1973). (In Japanese).

By the construction of clementine and EBR-1, the feasibility of FBRs was demonstrated. The state of FBR development in the countries pursuing their own development is reviewed, centering in individual reactors. Among the features of the FBR development are the current usage of oxide fuels and Na coolants, course of experimental through prototype to large scale reactors, and differing views concerning safety aspects. (JA)

1956 OVERALL STATUS OF LMFBR DEMONSTRATION PLANT. Copeland, R. L. (Project Management Corp., Chicago). Proc. Amer. Power Conf.; 35: 161-167(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The best long-term hope for easing the energy crunch is the nuclear power and, specifically, the liquid-metal-fast-breeder reactor. Tennessee Valley Authority and Commonwealth Edison

accepted a proposal from the AEC to construct the demonstration plant near Oak Ridge, Tennessee. The Breeder Reactor Corporation and Project Management Corporation were incorporated in March 1972 as a result of the efforts of TVA and CECo. The plant will be designed for a 30-year life, with an electrical rating of about 400 megawatts. The temperature of the sodium leaving the reactor will be about 1000°F. There will be three heat transport loops and the primary sodium pump will be located in the hot leg between the reactor vessel outlet and the IHX. Argon will be the cover gas for the primary and secondary systems. Technology exists for the design of a safe, operable, and reliable plant and remains to be applied to the engineering and fabrication of large-scale high-quality LMFBR components. The funding of the project is briefly described. (MCW)

1957 STATUS OF NUCLEAR STEAM SUPPLY SYSTEM DESIGN FOR THE LMFBR DEMONSTRATION PLANT. Kenney, J. (Westinghouse Electric Corp., Madison, PA). Proc. Amer. Power Conf.; 35: 168-179(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The status of the NSSS design involves the listing of the firm design criteria made to data and the design objectives being factored into the design effort. Reliability is ensured by making maximum use of FFTF design and developments in the fuel and control assemblies, the pumps, valves, heat exchangers, control rod drives mechanisms, reactor and guard vessels, the piped plant configuration, and the refueling systems. Safety is ensured by core decay heat removal through natural circulation, by a compliant and resilient passive core restraint system, and by application of the exceedingly intensive and ultra-complete FFTF safety design criteria and data. Maintainability is enhanced by the piped compartmented primary system; primary loop isolation valves that afford maintenance with partial power availability; the choice of a modular steam generator. Environmental effects are minimized because of the relatively low waste heat discharge associated with the high plant efficiencies, and because no controlled radioactive effluent is required or permitted. Economy prospects are ensured from flexibility for demonstration of advances in performance features. (MCW)

1958 LMFBR MODULAR STEAM GENERATOR TEST RESULTS. McDonald, J. S.; Harty, R. B.; Debear, W. S. (Atomics International, Canoga Park, CA). Proc. Amer. Power Conf.; 35: 180-188(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

Test results of a 28-MW(t) prototype Modular Steam Generator at the Sodium Component Test Installation at the Liquid Metal Engineering Center are discussed. The unit is designed to supply steam at 2400 psig/900°F, but testing is also being carried out at 1450 psig steam conditions. Brief descriptions of the MSG prototype and of the Sodium Component Test Installation are submitted. (MCW)

1959 REALIZING THE POTENTIAL OF THE BREEDER. Feathers, L. A. (General Electric Co., Sunnyvale, CA). Proc. Amer. Power Conf.; 35: 189-197(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The criticality of the current energy situation points out the necessity for the development of the LMFBR. Nuclear power has proven itself to be safe in the long experience of the Light-water Reactor industry, and LMFBR power will be equally so through the application of design standards, quality assurance requirements, and the knowledge of all the previous experience of the nuclear industry. The LMFBR is a highly efficient system with low effluent and thermal pollution; produces minimum disturbance of the environment; requires low volumes of materials and creates little waste materials; is safe, reliable, and economical. (MCW)

1960 STATUS AND SAFETY ASPECTS OF THE 300-MWe GCFR DEMONSTRATION PLANT. Milioti, S. J. (American Electric Power Service Corp., New York); Larrimore, J. A. Proc. Amer. Power Conf.; 35: 198-208(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The status of the design and development of the 300-MW(e) Gas-Cooled Fast Breeder Reactor and its safety aspects are presented. The GCFR offers a most attractive and viable alternative to the LMFBR. Operability and maintainability appear promising. The principal safety costs and schedules for a construction project have been completed. GCBR licensing requirements can be based on HTGR and LWR precedents. (MCW)

1961 FAST REACTOR CORE DESIGN. Beckett, V. S.; Board, J. A. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 3-12 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Support systems for fast reactor cores were analyzed and fuel element loads and deflections evaluated where restraint was applied. These were obtained for various conditions of irradiation and thermal creep. It was concluded that a pre-requisite for the successful design of a restrained core was an accurate assessment of irradiation creep rates. Embrittlement of the core support components as a result of irradiation was also considered and a fracture mechanics approach recommended for further evaluation exercises. (auth)

1962 FAST FUEL PIN MODELLING. Hicks, E. P.; Hughes, H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). pp 13-21 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The mechanical endurance of fast reactor fuel pins is determined by the complex interactions between many different factors, including creep and swelling of both fuel and cladding. The computer code SLEUTH has been written to explore these interactions quantitatively, and to predict stresses and strains in the fuel cladding during representative rating and temperature histories. Significant cladding stresses may be caused by one or more of the following mechanisms: a mechanical interaction between fuel and cladding when the fuel attempts to expand more than the cladding during a power increase; an analogous mechanical interaction at steady power when the fuel swells at a faster rate than the cladding; and internal stresses due to differential thermal expansion and differential swelling within the cladding. Numerical results are presented which illustrate the importance of each of these mechanisms for typical fast reactor fuel pins, and show how the stresses are modified by irradiation creep of the cladding. (auth)

1963 POST-IRRADIATION MECHANICAL PROPERTIES OF AUSTENITIC ALLOYS AND EFFECTS OF INTERGRANULAR FISSION PRODUCT ATTACK. Ring, P. J.; Busboom, H. J.; Spalaris, C. N. (General Electric Co., San Jose, CA). pp 197-208 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

The effect of high strain rates during a reactor transient have been evaluated by tensile tests on irradiated austenitic stainless steels. At the high strain rates, typical for transient conditions, all the stainless steel alloys tested exhibited ductility and strength values substantially higher than the values obtained during conventional tensile tests. Burst rupture tests have been carried out on irradiated fuel rod cladding to determine the effect of intergranular attack on burst rupture strength and ductility and so to assess the ability of the weakened cladding to withstand reactor transient conditions. Although ductility is sharply reduced due to the intergranular attack, rupture strength properties are higher than anticipated using a wall thinning allowance calculation. (auth)

1964 PLASTIC DEFORMATION IN EXPERIMENTAL FAST REACTOR FUEL RODS. Appleby, W. K.; Hilbert, R. F.; Baily, W. E. (General Electric Co., San Jose, CA). pp 209-216 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Plastic deformations in claddings of mixed oxide fuel rods irradiated in EBR-II have been determined experimentally. These deformations were up to 1.5% $\Delta D/D$ for rods irradiated up to 11 atom % burnup. For rods clad with solution annealed stainless steels it was found that most of the cladding plastic deformation occurred before about 6 atom % burnup. From the data obtained in these experiments it is possible to predict fuel-clad mechanical interactions for LMFBR fuel rods so that design bases can be established. (auth)

1965 NON-DESTRUCTIVE EXAMINATION OF FUEL ASSEMBLIES OF A FAST BREEDER REACTOR. Removille, J. (Commission of the European Communities, Luxemburg); Wagener, H. Kerntechnik; 15: No. 12, 548-553(Dec 1973). (In English and German).

Luxatom has studied, in connection with its research program on fast breeder reactors, the possibilities of radiographic examination of fuel assemblies after a decay time of 4 days. The parameters governing the loss of image definition are reviewed and experimental data is presented. Eight possible methods are dis-

cussed. The neutron flux densities from the reactor core itself or from a pulsed neutron source are just sufficient to obtain acceptable images of the fuel rod bundle, but no quantitative information can be expected. It is only possible to detect fuel rod bending of the order of 1 mm or abrupt defects in the gaps between the fuel rod rows. (GE)

1966 HETEROGENEOUS FAST REACTOR. Barker, A. (to United Kingdom Atomic Energy Authority). German (FRG) Patent 1,439,829. 16 Aug 1973. 8p. (In German).

A description is given of a reactor cooled by steam under pressure, where the cooling medium in the core is under supercritical pressure. Feedwater heating equipment is proposed which preheats the cooling medium fed into the core to such an extent that the increase in temperature in the cooling medium, due to the heat transferred by the fuel elements, is less than 200°C. The core is enclosed in a double-walled pressure vessel. The vessel is constructed to permit the circulation of water under supercritical pressure between the walls. (GE)

1967 BREEDER REACTOR OPERATED BY FAST NEUTRONS. Noderer, L. C. (to United States Atomic Energy Commission). German (FRG) Patent 1,514,962. 15 Mar 1973. 8p. (In German).

The described sodium cooled fast breeder reactor has in its intermediate zone between the breeding blanket and the core, tubes parallel to the core axis containing fertile material. The tubes contain in the middle region of their longitudinal range opposite the neighboring cooling circuit, closed chambers filled with gas. The cooling medium is forced through the core, blanket zone and over the walls of the chambers. The core zone contains more fissionable material than it produces whereas the intermediate zone and the blanket zone produce more fissionable material than they contain. (GE)

1968 DYNAMICAL BEHAVIOR OF CYLINDRICAL SHELLS IN STATIONARY AND FLOWING LIQUID ENVIRONMENTS. Milan, D. (Societe B.V.S., Grenoble, France). pp 397-424 of Recherches Actuelles et Applications Industrielles. Paris; Eyrolles (1973). (In French).

From fluid mechanics summer school; Ermenonville, France (4 Sep 1972).

An example from Phenix is used to illustrate this method of studying the dynamical response of cylindrical structures to random pressure fluctuations resulting from the turbulence of a liquid flowing around these structures. A hydraulic model is used to determine the excitation. The vibrational characteristics are determined by an overall method using a mechanical model. An upper limit to the response is determined using only the specific characteristics and the direct spectral densities of the exciting pressures. This is sufficient for guaranteeing the mechanical stability of the structures considered after a possible stiffening. Nevertheless a more elaborate calculation was developed in view of future requirements. This calculation takes the co-spectral densities of the exciting pressures into account. Interesting results were obtained which, however, require supplementary experimental confirmation. (FR)

1969 REACTOR BN-350 START-UP. Leipunskii, A. I.; Mitenkov, F. M.; Orlov, V. V. At. Energ. (USSR); 36: No. 2, 91-97(Feb 1974). (In Russian).

The first industrial atomic power plant based on fast reactor BN-350 began power operations on July 16, 1973 in Shevchenko. After reaching its nominal power level of 1000 MW(t) the reactor will produce 150 MW of electrical energy and 120,000 m^3/day of fresh water. The major construction and start-up stages of the BN-350 reactor are outlined. Experience with coolant preparation and start-up operations is summarized. There are also described the results of investigating reactor dynamic characteristics and power start-up. (5 references) (auth)

1970 INVESTIGATION OF PHYSICAL CHARACTERISTICS OF REACTOR BN-350 DURING START-UP. Orlov, V. V.; Pomerantsev, G. B.; Yurchenko, D. S. At. Energ. (USSR); 36: No. 2, 97-103(Feb 1974). (In Russian).

The results of measuring static physical characteristics of fast power reactor BN-350 are presented. The reactor reached criticality on November 29, 1972. Data obtained are compared with values predicted on the basis of calculations. (12 references) (auth)

1971 INVESTIGATION OF RADIATION LEVELS DURING REACTOR BN-350 START-UP. Yurchenko, D. S.; Tverdovskii, N. D.; Kulakovskii, M. Ya.; Tsurukin, Yu. P.; Romashkin, B. G.; Sergeev, V. A.; Sergin, G. M.; Bakumenko, O. D.; Skorikov, N. V. At. Energ. (USSR); 36: No. 2, 107-112(Feb 1974). (In Russian).

Data on radiation investigations during reactor BN-350 start-up are presented. As a result of measurements, there were determined the activity of coolant and gas volumes of the reactor, and also radiation levels. These measurements made it possible to obtain radiation data for locations inaccessible after reactor operation in a power regime. The obtained experimental data are compared with the design values. (7 references). (auth)

1972 DEVELOPMENT OF COMMERCIAL FAST BREEDER REACTOR. Nakagawa, H. (Tokyo Electric Power Co., Inc.). Genshiryoku Kogyo; 19: No. 6, 26-32(Jun 1973). (In Japanese).

1973 RADIOLOGICAL HAZARDS AROUND THE PHENIX REACTOR. Meffre, P. (Centre de Marcoule, Bagnols-sur-Ceze, France). pp 111-114 of Seventh National Congress of the Health Physicist's Association. Marseilles; Centre National de la Recherche Scientifique (1973). (In French).

From seventh national congress on control of ionizing radiation: pollution, dosimetry, applications; Marseilles, France (16 May 1972).

Phenix is the first French electric power plant employing a fast neutron breeder reactor. The utilization of large quantities of plutonium and high temperature liquid sodium coolant give a public image of a potential hazard having few advantages over more classical types of installation. The research already conducted together with the experience acquired in France with Rapsodie and abroad with similar types of reactor should dispel any such fears. The safety equipment envisaged for Phenix together with the particularly careful confinement of the circuits and radioactive wastes and the small amounts of waste which will be rejected into the environment guarantee an efficient protection of the personnel and surrounding population. (FR)

1974 SIMULATION OF A MINOR NON-CONTROLLED POWER ACCIDENT IN THE SNR-300 BY MEANS OF THE SAS3A PROGRAM SYSTEM. Royl, P. (Kernforschungszentrum, Karlsruhe, Ger.); Smith, L. L.; Stevenson, M. G. (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

The new SAS3A system has been used for the calculation of a 1/sec overpower accident for the MARK I core under the assumption of a 100 days core and for a core of the beginning of the 117 days equilibrium cycle for three different failure criteria. Some characteristic results such as prompt criticality and disassembly are dealt with. (GE)

1975 DEMOUNTABLE UPPER SHIELDING FOR A NUCLEAR REACTOR CORE. Brandstetter, R.; Robin, M. (to Commissariat a l'Energie Atomique). French Patent 2,161,805. 30 Nov 1971. 10p. (In French).

A demountable upper shielding for the core of an integrated type liquid sodium cooled nuclear reactor is presented. The special features of this shielding are that it consists of cylindrical metallic bottles filled with shielding elements. These elements are assembled on an axle provided at its upper end with a part which can be hooked into and used to raise the elements up. The bottle assembly forms an array; the different arrays test on floors connected respectively, to both the large and small reactor plugs by a metallic framework. The floor presses against the lateral parts which protect the reactor core. (FR)

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Refer also to abstracts 375, 392, 1924, 1929, 1934, 1939, 1940, 2154, and 2159.

1976 (ANCR-1141) START-UP TESTS FOLLOWING ATR BERYLLIUM REPLACEMENT: CYCLE 15. Close, J. A.; Kaufman, N. C.; Napper, P. R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Apr 1974. Contract AT(10-1)-1375. 83p. Dep. NTIS $5.45.

The ATR was shutdown on October 14, 1972 for partial replacement of the beryllium reflector. Results of the fueling and start-up testing program prior to full-power operation following reflector replacement are presented. The results of this nuclear testing program show that there are no unexpected differences between the ATR and ATRC, that the new reflector is essentially the same as the original, and that the calibration of the ^{16}N lobe power monitor system was not affected by the replacement. (auth)

1977 (ANL-8066) ANALYSIS OF THE FFTF PRIMARY-SYSTEM RESPONSE TO AN HCDA. Chang, Y. W.; Gvildys, J. (Argonne National Lab., Ill. (USA)). Jan 1974. Contract W-7405-109-eng-38. 41p. AT.

The analysis of the FFTF primary-system response to a hypothetical core-disruptive accident of 150 MW-sec using the REXCO-HEP computer code is presented. REXCO-HEP is the latest version of the REXCO code that treats not only the hydrodynamics, but also the elastic and plastic deformation of the reactor structures and components. The mathematical model of the FFTF reactor is described in detail, particularly in the areas of modeling of reactor internals and extending the time range for which reliable calculation can be made. The basic assumptions and limitations of the model are also discussed. (26 references) (auth)

1978 (ANL-CT-74-11) OPERATING CHARACTERISTICS OF THE FFTF 8-INCH SECONDARY SET/ISOLATION VALVE WITH VARIOUS ANNULAR GAP CONFIGURATIONS. Folkrod, J. R.; Rohde, R. R. (Argonne National Lab., Ill. (USA)). Mar 1974. 28p. AT.

The second and last phase of an experimental test project in support of the sodium freeze-seal design of the FFTF 8-inch secondary set/isolation angle valve has been completed. This project represented a continuation of an earlier testing program that explored the original design parameters of the valve that included cooling fins on the valve bonnet. Upon completion of the first testing phase, other designs of the freeze-seal were investigated. (auth)

1979 (ANL-CT-74-13) OPERATING CHARACTERISTICS OF ROTARY MOTION SODIUM FREEZE SEALS FOR THE FFTF PRIMARY VALVE. Folkrod, J. R.; Rohde, R. R. (Argonne National Lab., Ill. (USA)). Apr 1974. 44p. AT.

Tests were performed on a prototypic valve bonnet of the 28 in. FFTF Primary Isolation Valve. Plant operating and installation conditions were duplicated for the test to obtain representative valve freeze seal operating data. Data obtained were: 1) forces required to shear the sodium seal, 2) seal casting procedures, 3) location of the seal in the bonnet, 4) effectiveness of the cooling fins, 5) bonnet temperature profile and 6) blowdown effectiveness. No extrusion of the sodium seal was encountered like it was with the linear type freeze seals. This was expected and due to the lack of extrusion the torque required to shear the seal was constant throughout the testing of a given seal. No freeze seal operating difficulties were encountered during extensive testing. The stem was turned through a 100° arc at a rate of 60°/min for hundreds of cycles proving the adequacy of the design. (auth)

1980 (ANL-CT-74-45824-2) SUMMARY OF TEST RESULTS FROM EXPERIMENT NI-2 FOR THE RSN-286, S/N M402 AND THE WX-31384, S/N 703902 FISSION COUNTER-CHAMBERS BEING TESTED IN THE EBR-II NITF J-2 THIMBLE AT 700°F. Installation (August 1972) Thru Run 58 (October 1972). Yingling, G. E.; Elsbergas, V. J. (Argonne National Lab., Ill. (USA)). 22 Mar 1974. 42p. AT.

A summary is presented of test results from the testing of two fission counter-chambers in the EBR-II J-2 thimble of the Nuclear Instrument Test Facility (NITF). The two fission counter-chambers being tested as Experiment NI-2, are a Reuter–Stokes model RSN-286, S/N M402; and a Westinghouse model WX-31384, S/N 703902. Information is presented on the detectors performance, operating conditions and the overall status of the NI-2 testing program. This report covers the installation of the detectors in the J-2 thimble prior to Run 57 in August 1972, Reactor Runs 57 and 58 and the following shutdown until the detectors were disconnected from the Experimental Test Instruments and mated to commercial Wild Range Neutron Monitoring Systems prior to Reactor Run 59 in October 1972. (auth)

1981 (BARC/I-209) COOLANT FLOW DISTRIBUTION IN APSARA CORES. Nath, M. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 24p. INIS.

As the central fuel elements of Apsara core are relatively at higher power level, the coolant channels in this region will share more coolant as compared to the outer ones, thus resulting in a nonuniform flow distribution. An analytical method is described and a few calculations were performed for forced and natural flow conditions. (auth)

1982 (HEDL-SA-647) ANALYTIC MODELING OF THE MARK-IIA TREAT LOOP FOR FUEL MOTION AND SODIUM EXPULSION STUDIES. Sonnichsen, J. C.; Partain, W. L.; Shields, R. J.; Waltar, A. E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Apr 1974. Contract AT(45-1)-2170. 21p. (CONF-740401-9). Dep. NTIS AT(45-1)-2170. 21p. (CONF-740401-9). Dep. NTIS $4.25.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

An analysis of the H5 and E6 transient overpower experiments in the MARK-IIA loop of the TREAT reactor has been performed using a modified version of the MELT-III reactor safety code. In addition to program modifications required for modeling the MARK-IIA loop and test cluster design, a three step process was incorporated to allow computer simulation of the test chronology from the pre-irradiation process through transient testing. Results to date indicate that the coolant expulsion pattern observed in the H5 experiment can be simulated quite well by a mild molten fuel/coolant interaction (MFCI) process, whereas the E6 expulsion pattern can be best fit by modeling an initial fission gas release. These results appear to be consistent with the microstructure existing in the test pin, i.e., H5 had a medium power microstructure largely deplete of fission gas, and no central void, whereas E6 contained a high power microstructure and a central void containing fission gas. Definite conclusions cannot yet be drawn because of possible uncertainties associated with simulating a 7-pin cluster with a single pin model. However, the procedure established appears valid for the first 30 to 50 msec following initial cladding rupture. Based on these results, plus intercomparisons with calculations from an explicit multi-pin model prior to failure, it appears that the MELT-III computer program can be used to simulate the general heat transfer and hydraulic features of the MARK-IIA loop. Direct results are now being obtained to improve both the MFCI and fuel motion models being currently used in FFTF safety studies. (10 references) (auth)

1983 (HEDL-SA-700) FFTF SCALE MODEL STRUCTURAL DYNAMICS TESTS. Stepnewski, D. D.; Fox, G. L. Jr.; Simpson, D. E.; Peak, R. D. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Mar 1974. Contract AT(45-1)-2170. 24p. (CONF-740401-10). Dep. NTIS $4.25.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

The structural dynamic response of a reactor system primary coolant boundary to a hypothetical core disruptive accident (HCDA) is analyzed based on scale model experiments. The Buckingham Pi Theorem is used to identify material and process parameter relationships between model and prototype required for exact similitude. Departures from similitude requirements in the scale model tests are identified, and the effects of these departures on full-scale vessel response are assessed. The analyses reported here show that the energy partitioning in the scale models, which were constructed from nickel-200 and used water as test fluid, does not significantly differ from energy partitioning predicted for a full-scale reactor system constructed from stainless steel and using sodium as coolant. Correction factors are developed for scaling the timing of dynamic loading events, and peak impact forces. Strain values observed in the model tests are corrected and scaled to a full-size reactor system. After the application of correction factors, the strain distribution pattern in a full-scale system is shown to remain similar to those which occurred in the tests. Using the conclusions developed in the analytical scale-up process, post-test observations on the vessel and pipe model are interpreted in terms of full-scale equipment. It was concluded that the primary coolant boundary would maintain its integrity under load conditions of a 150 MW-sec HCDA. No behavior was observed in the tests which could be interpreted as preventing in-vessel post-accident heat removal. (17 references) (auth)

1984 (HEDL-TME-73-83) BYPASS FLOW ORIFICE TESTS. Williams, L. S.; Spalek, J.; McCormack, J. D. (Hanford Engineering Development Lab., Richland Wash. (USA)). Mar 1974. Contract AT(45-1)-2170. 84p. AT.

In the FFTF, the bypass flow is regulated by the clearances between the lower portion of the control, fuel, and inner reflector assembly nozzles and the core basket receptacle liners. The bypass flow is used to cool critical vessel, storage, and core barrel areas. The purpose of the bypass flow orifice tests was to perform a series of hydraulic tests over a range of postulated conditions and nozzle-liner gap sizes to provide flow coefficient data to establish the reference design dimensions of the fuel assembly lower nozzle. The data presented plus the statistical prediction of nozzle-liner configuration distribution for the entire core, will provide the support for the final nozzle selection. (auth)

1985 (HEDL-TME-74-6) PARAMETRIC STUDY OF THE TRITIUM DISTRIBUTION IN THE FFTF. Kabele, T. J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1974. Contract AT(45-1)-2170. 28p. AT.

This parametric study indicates that tritium release from the FFTF can be held to less than 0.5 Ci/day through effective cold-

trapping of the sodium of the primary and secondary coolant systems. This release level is a factor of between 100 and 1000 times less than the allowable statutory release rates for tritium. (auth)

1986 (HEDL-TME-74-8) CCTL MARK II AND II-A FINAL EXAMINATION. Myers, R. L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1974. 52p. AT.

A prototypic FTR driver fuel assembly completed a life test in the Core Components Test Loop (CCTL) at Argonne National Laboratory (ANL). The assembly was shipped to the Hanford Engineering Development Laboratory (HEDL) without draining the sodium or cleaning the assembly. At HEDL, the assembly was partially disassembled for a preliminary visual inspection and then cleaned. The final examination included a detailed visual examination of each component, analysis of foreign particles, dimensional characterization for comparison with pre-test and interim examination data, measurement of surface finish of cladding and wire, and a destructive examination of two fuel pins to investigate the surface characteristics of cladding and wire. The inspection results do not show any evidence of structural damage, vibration wear, or loose wires. Shortly after the interim examination at 6000 hours, there was an approximate 20% increase in pressure drop across the assembly. No evidence of any condition within the assembly which would account for the increase was found during the final examination. The cladding and spacer wire surfaces were examined with metallography, scanning electron microscope, electron microprobe, Auger Electron Spectroscopy and Vicker's Diamond Point Hardness (DPH) measurements were made. A thin (~2μ deep), chromium rich surface film was identified on the lower $\frac{1}{3}$ of the fuel pins. A depletion of chromium, iron, and nickel was observed on the surface and nitriding of the cladding occurred. 5 references. (auth)

1987 (INIS-mf-1051) CALCULATIONS ON FUEL IRRADIATION IN THE 100 MW THERMAL RESEARCH REACTOR. Rastogi, B. P.; Balakrishnan, K.; Nakra, A. N. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 6p. INIS.

From symposium on nuclear science and engineering; Bombay, India (13 Mar 1973).

Irradiation testing of power reactor fuel elements under power reactor conditions is one of the essentials of a fuel development program. Some calculations on the specific powers obtained in a test bundle when it is irradiated in the proposed thermal research reactor which is to be set up at Trombay are presented. The test bundle chosen for calculations was the natural UO_2 28-rod cluster fuel element of the 500 MW(e) reactor. It is found that the specific power obtained in the test bundle is only about 15.7 kw/kg as opposed to a value of 34 kw/kg in the power station. It is further shown that this specific power can be increased by irradiating the same fuel pins in the form of 19 or 7 rod clusters, or by enriching the test bundle itself. The 19 or 7 rod cluster cannot reproduce exactly the coolant flow pattern and heat transfer characteristics of the 28 rod clusters, while enriching the test bundle will give flux distributions within the cluster which are completely at variance with that which exists in the natural uranium cluster. It is for the fuel designers to decide, whether, under such conditions, meaningful conclusions can be drawn from irradiation testing or whether some alternative method has to be found for attaining higher specific powers. (auth)

1988 (JAERI-M-5360) OPERATION REPORT ON THE LOW TEMPERATURE FISSIOCHEMICAL LOOP (LTFL), 3. Operations During the Period of April 1971 to March 1972. Sato, S.; Moriyama, N.; Ikezoe, Y.; Shimizu, S.; Kobayashi, T. (Japan Atomic Energy Research Inst., Tokyo). Aug 1973. 16p. (In Japanese). NTIS (US Sales Only).

The Low Temperature Fissiochemical Loop (LTFL) was operated eleven times, irradiating 55 capsules during the F. Y. 1971–1972 period. Three low temperature runs were included. The loop operation was satisfactory, except a few troubles dealt with suitable measures. Irradiations were made for (1) fission fragment dosimetry with ethylene and evaluation of the dose rate calculation, (2) measurement of the background reactor radiation dose rates in the loop, (3) hydrogen cyanide formation in nitrogen-ethylene systems by fission fragments, and (4) measurement of the extent of the reaction product contamination with fission products. The experimental results have been reported seaprately. The number of capsules as classified by the reactants; 28 capsules containing ethylene (including 5 capsules for the contamination study and 11 capsules for the background radiation dosimetry), 25 capsules containing mixtures of nitrogen and ethylene (including 11 capsules for the measurement of background reactor radiation reaction), and 2 capsules containing $^{14}N^{15}NO$ for dosimetry study. For the loop maintenance, the helium compressor was overhauled and pressure gages and thermometers (recorders, indicators and alarms) were checked and calibrated in the last quarter of the F. Y. (auth)

1989 (JAERI-M-5421) OPERATION REPORT ON THE LOW TEMPERATURE FISSIOCHEMICAL LOOP (LTFL), 4. Operations During the Period of April 1972 to March 1973. Sato, S.; Moriyama, N.; Kobayashi, T.; Ikezoe, Y.; Shimizu, S. (Japan Atomic Energy Research Inst., Tokyo). Oct 1973. 49p. (In Japanese). NTIS (US Sales Only).

The Low Temperature Fissiochemical Loop (LTFL) was operated six times, irradiating 24 capsules during the F. Y. 1972–1973 period. Capsules of improved design were used for the second run, with which 3 inner capsules, i.e., 3 samples, were irradiated simultaneously in one outer capsule. The safety aspects of the design and the test results of the new capsule were reviewed by the Committee on the Operation and Maintenance of Reactors, JAERI. With 24 capsules, 49 samples were thus irradiated during the period. The safety of the chemical irradiation systems containing ammonia and hydrocarbons was also examined. The fifth run twice encountered operational troubles in the procedure of bringing the irradiated capsule out of the irradiation plug of the loop; its cause is being investigated at present. Other runs were successful of which the last (sixth) was a low temperature operation. The number of the irradiation samples as classified by the systems; 15 samples were of ethylene (11 samples for the deposition efficiency experiment of fission fragments and 4 samples for the background reactor radiation dosimetry), 22 samples were mixtures of ammonia and ethane, 4 samples each of ammonia and ethylene or propylene, and 4 solid samples for radiation damage experiments. Maintenance works on the loop are also described, and the irradiation experiments outlined. (auth)

1990 (JAPFNR-144) TENTATIVE DESIGN OF IRRADIATION FACILITIES FOR JOYO. (Hitachi Ltd., Tokyo (Japan)). Mar 1972. 111p. (PNC-J-202-72-9-1). Dep. NTIS (US Sales Only) $8.75.

For Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan).

The descriptions and figures on the structure and function of the fuel irradiation and material irradiation assemblies, the descriptions of the methods of irradiation and post-irradiation tests, and an outline of information obtained from the irradiation tests are presented. The results of irradiation tests and irradiation plans in foreign countries, the subjects raising discussions on the in-core behavior of fuel and material, a proposal on the irradiation plan in the core of "Joyo" Mark-II, and the investigation on the characteristics of measuring instruments to be installed in the irradiation assemblies are included. (26 references) (auth)

1991 (KFK-1913) ANALYSIS OF FUEL ROD STRESS UNDER POWER CYCLING. Evaluation of Experimental Data from FR2 Capsule Experiments No. 4a, 4b, 5b, and BR2 Experiment Mol 8B as Compared to a Theoretical Model. Gerken, A. (Kernforschungszentrum Karlsruhe (F. R. Germany)). Feb 1974. 78p. (In German). Dep. NTIS (U. S. Sales Only) $7.00.

The mechanical interactions between fuel and cladding are analyzed. In the fuel rod irradiation program in the thermal reactor FR2, many pins have reached high burnups without any failure, but with large diameter increase (1.0 – 2.5 % Δd/d). The reasons apparently were given by power changes in the pins, during operation. A modeling analysis explains that only the non-steady state conditions create these large diameter increases. With a computer code all the parameters in this field were analyzed. A fuel design and irradiation conditions are described which may bring down the mechanical interactions to zero. (13 references) (auth)

1992 (KURRI-TR-111) INVESTIGATION ON THE RADIOACTIVE ARGON GAS PRODUCED IN KYOTO UNIVERSITY REACTOR. Tsujimoto, T. (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.). Oct 1972. 21p. (In Japanese). Dep. NTIS (U. S. Sales Only) $4.25.

Investigation was carried out on the radioactive argon gas produced in Kyoto University Reactor (KUR). Most of the radioactive argon gas is produced in the facilities of nuclear reactors. The radioactive argon gas produced in the facilities is released from a stack by two ways; it is exhausted from the stack through vent pipe connected to facilities, and from the stack via reactor room from the facilities. The volume of radioactive argon gas produced in the facilities was calculated and its radioactivity in the stack and reactor room was measured. The results obtained are as follows: (1) the total radioactivity of argon gas produced in the nuclear facilities was approximately 100 mCi/sec; (2) the radioactive argon gas leaked from nuclear facilities to reactor room was approximately 5 μCi/sec; and (3) the radioactive argon gas released from the stacks of nuclear reactors was approximately 33 μCi/sec. According to the results, methods on the health physics supervision and control of argon gas are discussed. 11 references. (auth)

1993 (ORNL-TM-4448) TEMPERATURE DISTRIBUTION IN A 19-ROD SIMULATED LMFBR FUEL ASSEMBLY WITH A SIX-CHANNEL INTERNAL BLOCKAGE. Fontana, M. H.; MacPherson, R. E.; Gnadt, P. A.; Kress, T. S.; Parsly, L. F.; Wantland, J. L. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 32p. AT.

Experiments were performed with a 19-rod test assembly in the Fuel Failure Mockup (FFM) sodium loop in which Liquid Metal Fast Breeder Reactor (LMFBR) fuel rods were simulated by electrical cartridge heaters having the same external configuration, spacer arrangement, temperature, and heat flux as those of the Fast-Flux Test Facility (FFTF). The test assembly was constructed with a device that blocked the central six subchannels surrounding the central rod at an elevation 15 in. downstream from the start of the heated zone. Temperatures were measured throughout the rod bundle, with particular emphasis on the region in the vicinity of the blockage and at the exit of the rod bundle, at flows from 100 to 60% of full flow, and at linear heat fluxes of 10 and 7.5 kW/ft. Local temperature increases of about 100°F at full flow and at a linear heat flux of 10 kW/ft were measured. Temperature increases of about 150°F were measured at 60% flow. The exit temperatures of the blocked subchannels appeared to be higher, by about 20°F, than the unblocked values, which indicates that a non-heat-generating blockage of the configuration tested would be tolerable on the FFTF. (9 references) (auth)

1994 (ORNL-TM-4508) BULK SHIELDING FACILITY QUARTERLY REPORT, OCTOBER, NOVEMBER, AND DECEMBER OF 1973. Hurt, S. S. III; Lance, E. D.; Thomas, J. T. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 21p. Dep. NTIS $4.25.

The BSR operated at an average level of 1590 kW for 31.45% of the time during October, November, and December. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There was one unscheduled shutdown during the quarter. The PCA was not used during this report period and remains in a secured condition. (auth)

1995 (TID-24818, pp 170-176) ANALYSIS OF FLUX GRADIENTS IN IN-PILE CONVERTERS AND COMPARISON WITH EXPERIMENTAL DATA. Sawyer, C. D. (General Electric Co., Pleasanton, CA); Wilkins, D. R.; Hanvelt, R. A.; Gilliland, D. L.; Kunze, J. F. Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A simplified physical model was constructed for the design of a neutron shield to make the test thermionic fuel element (TFE) fuel power profile more uniform in a thermionic reactor test. In addition to the computation of a detailed fuel power profile, the activity of cobalt in the diode sheath was also computed for comparison with experimentally available sheath activities from an unshielded TFE test. Using this data, a silver shield was designed and constructed for use on subsequent irradiations. The effectiveness of this shield was determined from past irradiation cobalt activity measurements and through a series of low power reactor measurements. The low power reactor experiments were run on a 3-cell TFE located in a reflector region of the THRITS reactor which had been modified to mock-up the GETR test geometry. (auth)

1996 MOCK-UP TESTS OF MAIN COMPONENTS FOR EXPERIMENTAL FAST REACTOR JOYO. Yuasa, Y. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Japan). Doryokuro Giho; No. 7, 78-86(Apr 1973). (In Japanese).

The experimental fast reactor Joyo is constructed for obtaining technical experience for the development of the prototype "Monju," demonstration reactor and commercial reactors which will follow. Mock-up tests of major components were carried out to obtain information before the assemblage of the Joyo. Models of full size, which had been tested by respective makers, were gathered and assembled in the Oarai Engineering Center. The work consisted of three phases: (1) assemblage of the components including reactor vessel, core structure and fuel assembly, rotary plug, fuel handling machinery, and control rod driving mechanism; (2) separate tests of the fuel handling machines including those for fuel exchange and transfer, both in air and sodium environment; (3) and the overall mock-up tests with all the components put together in both air and sodium environment, especially concerning the handling of fuel. Preciseness of the assemblage and other works was observed to be quite satisfactory, and also information for the future improvement was provided. (JA)

1997 TEMPERATURE TRANSIENTS AFTER SIMULATED FAILURE OF PUMP POWER SUPPLY IN THE EWA RESEARCH REACTOR. Strupczewski, A.; Nycz, C. (Univ., Lodz, Poland). Nukleonika; 18: No. 12, 593-601(1973).

Temperature transients in the EWA research reactor were studied under simulated accident conditions in which the power supply to two or three pumps in the primary circuit was switched off. The reactor was operated at full rated power and shut off by safety rods when the flow decreased below the scram value. The measurements covered the initial period of rapid temperature changes and the subsequent period of slow changes connected with the flow reversal process. The data were recorded for a wide range of reactor operation parameters, including the highest power level permissible in a WWR-SM reactor and have been the basis for a significant increase of the reactor EWA operational power. 4 references. (auth)

1998 EFFECT OF LOCAL FLUX DISTORTIONS ON THE DOPPLER EFFECT OF SMALL FISSILE SAMPLES. Kier, P. H.; Salvatores, M. (Argonne National Lab., IL). Nucl. Sci. Eng.; 53: No. 4, 479-482(Apr 1974).

Samples used in Doppler-effect measurements in fast critical assemblies distort the flux in their vicinity. For fissile samples whose Doppler effect depends strongly on spectrum, this distortion may strongly affect the measured results. An integral transport method for computing distorted real and adjoint fluxes is developed and the fissile-sample Doppler measurements in a fast critical assembly, ZPR-6 Assembly 7, are analyzed. It was found that the local flux distortions strongly affect the results and for a PuO_2 sample even change the algebraic sign of the Doppler effect. (auth)

1999 USE OF ^{252}Cf AS A RANDOMLY PULSED NEUTRON SOURCE FOR PROMPT-NEUTRON DECAY MEASUREMENTS. Mihalczo, J. T. (Union Carbide Nuclear Corp., Oak Ridge, TN). Nucl. Sci. Eng.; 53: No. 4, 393-414(Apr 1974).

Cross-correlation measurements between the pulses from an ionization counter containing a ^{252}Cf neutron source, which provided the initiators of fission chains in a neutron-multiplying assembly, and the pulses from a detector observing the particles from the fission chains leaking from the assembly were performed for unmoderated and polyethylene-moderated uranium (~93 wt % ^{235}U)-metal cylindrical assemblies with uranium masses varying from 12 to 160 kg and with prompt-neutron decay constants varying from 3×10^3 to 10^5 sec^{-1}. The applicability of this randomly pulsed neutron method with ^{252}Cf as the neutron source for the determination of the prompt-neutron decay in plutonium was investigated in experiments with unmoderated plutonium–metal assemblies with masses varying from 2.2 to 16 kg and with spontaneous fission rates from ^{240}Pu varying from 4.5×10^4 to 8.2×10^5 fiss/sec. These assemblies included spheres and parts of spheres of plutonium with 4.5 or 20.1 at.% ^{240}Pu. The ratio of the correlated count rate in the randomly pulsed neutron method to that in a Rossi-α method is inversely proportional to the detector efficiency and was as large as 8000 for some assemblies where both measurements were made. Thus, the randomly pulsed neutron method allowed the determination of the prompt-neutron decay without the use of a complicated pulsed-neutron source where the Rossi-α method was not practical. In assemblies for which Rossi-α measurements were also made, the prompt-neutron decay constant agreed within the precision (<1%) of the measurements with those obtained in much less time by this technique. Since the prompt-neutron decay can also be determined for plutonium–metal assemblies with ~20 at.% ^{240}Pu, using a californium source as small as 3000 fiss/sec, this technique can be used for the subcriticality determination for both unreflected and unmoderated uranium (93.2)- or plutonium–metal assemblies. (auth)

2000 SAFETY MEASURES IN NUCLEAR RESEARCH. Proceedings of the Tripartite Meeting Held in Brussels, Belgium, April 19–22, 1971. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972). 218p. (CONF-710472-).

Separate abstracts were prepared for 11 of the 27 papers presented in these proceedings. Abstracts of the other 16 papers were published previously in NSA volume 28 as abstract numbers 21061, 21062, 21075, 21104, 21667, 21668, 21671, 21672, 21675, 21677, 21679, 21811, 23286, and 23875 and in volume 29 as abstract numbers 11918 and 11949. (ERB)

For abstracts of individual papers see: 291, 301, 318, 551, 552, 1000, 1001, 2001–2003, and 2221.

2001 SAFETY ASSESSMENT, SAFETY MEASURES, AND EMERGENCY PROCEDURES FOR THE HOR. Weber, J. (Interuniversity Reactor Inst., Delft, Netherlands). pp D.1.1-D.1.2 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

2002 SAFETY OF EXPERIMENTAL DEVICES IRRADIATED IN THE BR2 REACTOR. Penelle, G. (ASBL, Brussels). pp

D.3.1-D.3.5 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

Procedures for assuring the safety of irradiation capsules and the operation of experimental facilities of the BR-2 reactor are discussed. Operational requirements for individual experiments are considered for meeting safety criteria. (DCC)

2003 SAFETY REVIEW OF IRRADIATION EXPERIMENTS IN THE HFR AT PETTEN. Schoelvinck, R. G. (Reactor Centrum Nederland, Petten). pp D.4.1 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

2004 APPARATUS AND METHOD FOR MONITORING FISSION PRODUCTS. Dady, C. E. (to Government of the United States of America). Canadian Patent 915,831. 28 Nov 1972.

A failed-fuel detector suitable for use with pool-type reactors depends on the principle of detecting particulate daughters of gaseous fission products, particularly ^{138}Cs formed in the sequence $^{138}I \rightarrow {}^{138}Xe \rightarrow {}^{138}Cs \rightarrow {}^{138}Ba$. Water from the pool is continuously sampled into and out of a holding vessel. The gases above the holding vessel are themselves continuously sampled, and passed through a paper filter, which is scanned by a Ge(Li) radiation detector. The system eliminates radiation from ^{41}Ar, corrosion products, and atmospheric background. It is sensitive enough to detect the fission products from 10μg of ^{235}U. (CA)

2005 IMPROVED LONG PULSE IONIZATION SIMULATION USING PULSED REACTORS. Steichen, C. U.; Retzler, J. P.; Apodaca, L. (Rockwell International, Anaheim, CA). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-20: No. 6, 331-340(Dec 1973).

From annual conference on nuclear and space radiation effects; Logan, UT (23 Jul 1973).

Recently developed methods to improve the usefulness of pulsed nuclear reactors as sources for simulation of wide pulse ionization environments, generated by weapon produced neutrons, are described. These methods include the use of a special shield material which performs the dual role of attenuating neutrons and enhancing gamma dose rate, tailoring of pulse shapes by modifying the reactor burst characteristics through selective coupling between the reactor core and special reflector configurations, and use of special shield configurations to improve dose uniformity. Data obtained at the White Sands Missile Range Fast Burst Reactor and the Sandia Corporation SPR II for several shield configurations and reactor operating conditions are presented. Gamma radiation dose rates and 1 MeV damage equivalent neutron fluences obtained with and without use of the special shield material are compared. Dose rate enhancements of 5.2 and 3.3 times free fields were achieved behind shield thicknesses of 5 and 12 in., respectively. The respective neutron fluences were reduced by factors of 5.5 and 62. A peak dose rate enhancement of 12.4 times free field was achieved between slabs of shield material. Peak dose rates of 5×10^7, 1×10^7, and 1.2×10^6 rads (Si)/sec were achieved behind the shield material for pulse widths of 52 μsec, 100 μsec, and 1 msec, respectively, while limiting the neutron fluence to approximately 1×10^{11} n/cm^2. It is shown that peak dose rates of approximately 4×10^8, 1×10^8, and 1×10^7 rads (Si)/sec are obtainable for these respective pulse widths with an accompanying neutron fluence of 3.5×10^{12} n/cm^2. Side-to-side dose variation of less than 50 percent was achieved over a 4 ft wide area 16 in. from the core centerline. (auth)

2006 GAMMA STREAMING PROBLEM DUE TO LINING OF A RESEARCH REACTOR POOL WITH STAINLESS STEEL. Sarram, M.; Keshtkar, H.; Moghimi, J. (Teheran Univ.). Kerntechnik; 16: No. 1, 30(Jan 1974).

At the Tehran University Research Reactor a high leakage rate was observed, mainly from the joint between the heavy and the regular concrete in the pool walls. The pool was therefore lined with stainless steel. As a consequence of this, streaming of gamma radiation to the pool surface area took place. The design and construction of a lead shield to prevent the streaming is briefly described. (GE)

2007 BFS-1 MICROTRON INSTALLATION FOR INVESTIGATING FAST REACTOR NEUTRON SPECTRA. Leipunskii, A. I.; Orlov, V. V.; Kazanskii, Yu. A. At. Energ. (USSR); 36: No. 1, 3-5(Jan 1974). (In Russian).

The BFS-1 microtron installation for measuring fast neutron spectra by the time-of-flight method is described. The BFS-1 facility allows to model fast assemblies with core diameters up to 1.6 m. A pulsed mode of reactor operation is provided by introducing into the core a subcritical assembly of a pulsed neutron source. Such a source is provided by a microtron accelerator with target. A neutron beam is extracted from the central region of the assembly through the reentrant hole with a square (100 × 100 mm^2) cross-section. The flight path is 230 meters long. The neutron detector consists of a group of He^3-proportional counters located in a polyethylene block. Data on spectrometer background and rate of gathering information are given. As an example, the soft part of the neutron spectrum for the BFS-27 assembly is presented. (2 figures, 6 references) (auth)

Production and Materials Testing and Processing Reactors

Refer also to abstracts 1981 and 2197.

2008 (DUN-6181-C) PT-NR-125, SUPPLEMENT 6. A-B ELECTRICAL BUS HYDRAULIC INTERDEPENDENCE TEST OTP FOR AIR EXTRACTION SYSTEM (DC-3239). Baars, R. E.; Fields, K. E. (Douglas United Nuclear, Inc., Richland, Wash. (USA)). 20 Apr 1973. 27p. Dep. NTIS $4.50.

This test should conclude the PT-125 turbine generator (TG) surface condenser testing program, and serves as an Operational Test Procedure (OTP) for the new air extraction system being installed under authority of Design Change 3239. The new air extraction system is being installed to minimize the probability of loss of syphon on the CRW side of the TG surface condenser, which has been concluded to be responsible for the surface condenser flow-loss incidents that occurred in 1968-1969. The TG surface condenser has been operated since 1969 with flow rates substantially higher than specified by the original design, based on initial PT-125 test results which established that higher flow rates would ensure adequate condenser cooling at all times. With the new air extraction system, the TG condenser can be operated near design flow rates to provide for operation of the CRW system as intended by the original design. 12 references. (auth)

2009 (DUN-6181-D) PT-NR-125, SUPPLEMENT 6. Final Report, A-B Electrical Bus Hydraulic Interdependence Test OTP for Air Extraction System (DC-3239). Baars, R. E.; Fields, K. E. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 14 Nov 1973. Contract AT(45-1)-1857. 47p. Dep. NTIS (US Sales Only) $5.50.

The objectives of the test were: to demonstrate that the turbine generator can be operated with a high degree of reliability at near design coolant flow rates with the new AE system in operation; to collect data for a Technical Basis defining operation of the TG surface condenser at near design coolant flow rates when the AE system is in operation; and to obtain information on the CRW system flow distribution at near-design TG condenser coolant flow rates. Test results are presented. (auth)

2010 (DUN-8084-B) FINAL REPORT, PRODUCTION TEST-326 RADIATION MEASUREMENTS IN N-REACTOR REAR PIPE SPACES. Erickson, G. L.; Kratzer, W. K. (Douglas United Nuclear, Inc., Richland, Wash. (USA)). 27 Mar 1973. Contract AT(45-1)-1857. 43p. Dep. NTIS $5.25.

Production Test 326 authorized the evaluation and application of two newly developed radiation measuring instruments in the N-Reactor rear pipe spaces to precisely determine localized radiation sources. The instruments were: a guided traversing radiation measuring instrument employing a miniature radiation detector with an X-Y plotter readout for scanning V-12 valve radiation levels; and a hand-held radiation measuring instrument capable of directly reading radiation from pipe, valve, and other components and discriminating between radiation levels of adjacent surfaces. During the December 1972 N-Reactor scheduled outage, both instruments were evaluated in the rear pipe spaces. During the March 1973 outage the guide tubes for the traversing instrument were installed in rear pipe spaces 1 through 16 and a complete survey of V-12 valve radiation readings was taken. The radiation measuring instrumentation, the results obtained to date, and some of the implications of the data are presented. (auth)

2011 (INIS-mf-1105) NUCLEAR REACTOR PRODUCTION OF CARRIER-FREE ^{32}Si. Forberg, S. (Kungliga Tekniska Hoegskolan, Stockholm (Sweden)). Mar 1970. 11p. INIS.

Different suggested paths of a reactor production of the long-lived ^{32}Si are compared. The reaction series $^{31}P(n,\gamma)\ ^{32}P(n,p)\ ^{32}Si$ was found most promising. Experiences from absolute activity measurements by means of Cherenkov radiation and yields from reactor neutron irradiations of phosphorus are presented. (auth)

2012 (ORNL-TM-4580) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, OCTOBER, NOVEMBER, AND DECEM-

BER OF 1973. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn. (USA)). May 1974. Contract W-7405-eng-26. 22p. Dep. NTIS $4.25.

Reactor operation was routine with an on-stream time of 94.8% which brought the on-stream time for the year up to 94.0%, a record high for the HFIR. When the control plates were changed at the end of cycle 98, excessive wear of some control plate bearings was found. This bearing wear was a different type than had been previously experienced and is still under investigation. (auth)

2013 METHOD AND EQUIPMENT FOR UTILIZING THERMAL ENERGY AT HIGH TEMPERATURE, PARTICULARLY OF NUCLEAR ORIGIN. Souriau, D. (to Gaz de France). French Patent 2,135,421. 4 May 1971. 11p. (In French).

A process is presented which enables the cost from a nuclear power plant to be reduced by recovering the high temperature thermal energy dissipated in the reactor and using it to produce large quantities of commercially interesting hydrogen and oxygen. Heat is extracted from the reactor core by means of a coolant circuit in which liquid tin circulates (the liquid tin coming from the reactor is at a temperature of 1820 deg). A reactor having a thermal power of 840 MW produces an electrical power of 180 MW together with a simultaneous production of 100,000 m^3 of hydrogen and 50,000 m^3 of oxygen/hour at S. T. P. (FR)

Propulsion and Package Reactors

Refer also to abstracts 764, 2160, and 2161.

2014 (AAEC/LIB/Bib-408) NUCLEAR SHIPS: ECONOMIC AND SAFETY ASPECTS. A Bibliography, 1961–1973. Wybenga, I. M. (Comp.). (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1974. 40p. Dep. NTIS (U. S. Sales Only) $5.00.

One hundred and sixty-nine references are arranged alphabetically by author within each year. A section on bibliographies (12 refs.) is included. (AT)

2015 (AD-770109) PARAMETRIC STUDY OF THE COLLOID REACTOR ROCKET ENGINE. Computer Program for Predicting Colloid Core Fuel Vaporization Loss Rates. (Westinghouse Electric Corp., Pittsburgh, Pa (USA). Astronuclear Lab.). Sep 1973. Contract F33615-72-C-1197. 72p. (WANL-PR-6; ARL-73-220). NTIS. $3.50.

A parametric study was performed of the Colloid Core Reactor Rocket Engine. The computer program written to calculate fuel vaporization loss rates in the Colloid Core Reactor is described. The theoretical development of the model and the organization of the program are comprehensively discussed. Input instructions and a complete listing of the code are provided. A sample problem is used to illustrate and to define the output data. (auth)

2016 (BNWL-853) FUELED GRAPHITE STUDIES. Quarterly Progress Report, April–June 1968. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1968. Contract AT(45-1)-1830. 40p. Dep. NTIS $5.00.

Declassified 28 Aug 1973.

The effects of porosity on the hydrogen corrosion behavior of Rover fuel were studied. Untested and hot-gas-tested elements were examined by metallography and radiography. NbC was added to some of the elements. (DLC)

2017 (CNLM-4255) SNAP-50 SPACE POWERPLANT. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). 17 Sep 1962. Contract AT(30-1)-2789. 17p. Dep. NTIS $4.00.

Declassified 17 Sep 1973.

Design characteristics of the SNAP-50 space power reactor are presented. Reactor components and materials development programs are described. (DCC)

2018 (GEMP-600(Vol. 3)) 710 HIGH-TEMPERATURE GAS REACTOR PROGRAM SUMMARY REPORT. Volume III. Fuel Element Development. (General Electric Co., Cincinnati, Ohio (USA). Nuclear Materials and Propulsion Operation). 1967. Contract AT(40-1)-2847. 149p. Dep. NTIS $10.50.

Declassified 6 Sep 1973.

This volume of the 710 High-Temperature Gas Reactor Program Summary report contains a summary of the development program on the 710 multi-channel tubular W–UO_2 cermet fuel element. Included are results of the fabrication development effort and test program. (auth)

2019 (HW-83980) FUELED GRAPHITE STUDIES PROGRESS REPORT, APRIL–JUNE 1964. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 1964. Contract AT(45-1)-1350. 46p. Dep. NTIS $5.50.

Declassified 28 Aug 1973.

Research on graphite matrix-coated particle fuels for Rover included: material characterization, joining, NbC coating adherence, and fuel migration. (DLC)

2020 (NAA-SR-Memo-10579) SNAP SYSTEMS CAPABILITIES. (Atomics International Div., Canoga Park, Calif. (USA)). 19 Oct 1964. 535p. Dep. NTIS $28.75.

Declassified 28 Nov 1973.

Information on the technical capabilities of SNAP reactors as of October 1964 is presented. The information includes SNAP 10A, SNAP 10B, SNAP 8, advanced zirconium hydride systems, shielding, power conversion systems, and reactor power systems. (DCC)

2021 (TID-24818) PROCEEDINGS OF THE THERMIONIC CONVERSION SPECIALIST CONFERENCE, NATICK, MASSACHUSETTS, OCTOBER 23-24, 1968. (Army Natick Labs., Mass. (USA)). Apr 1969. 388p. (CONF-681059-). Dep. NTIS $21.50.

Information on thermionic conversion is presented concerning thermionic reactors and isotopic systems, converter testing, and materials development and performance. Separate abstracts are included for each of the 35 papers presented. (DCC)

For abstracts of individual papers see: 226, 227, 451, 452, 1995, 2022–2049, 2160, and 2161.

2022 (TID-24818, pp 10-27) EVALUATION AND SELECTION OF DESIGN PARAMETERS FOR THERMIONIC POWER SYSTEMS. VanHoomissen, J. E.; Voorhees, B. G.; Hill, P. R. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A summary is presented of progress during the last year in development of the nuclear thermionic reactor and power plant at General Electric. Design progress is reported by describing the features of a 300 kW(e) thermionic power plant for space electric power generation application. Progress in the experimental and analytical programs is presented in terms of this design. The discussion moves from consideration of the fuel emitter pair, through the combination of diodes to the thermionic fuel element, to the reactor as a whole, and finally to the power plant. (auth)

2023 (TID-24818, pp 28-37) THERMIONIC REACTOR SYSTEM DEVELOPMENT. Holland, J. W.; Pidd, R. W. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Gulf General Atomic's program of thermionic reactor systems development is described. Topics include: unit cell thermionic fuel element development; integration of fuel elements into liquid metal cooled reactor core; nuclear experiments and analysis; and reactor power plant analysis and design. Concept configurations are reviewed and significant developmental accomplishments or problem areas are highlighted. 19 references. (auth)

2024 (TID-24818, pp 38-48) 300-kW(e) EXTERNAL-FUEL REACTOR DESIGN. Abbate, M.; Eisen, C. L.; Raab, B.; Schock, A. (Fairchild Hiller Corp., Farmingdale, NY). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The design of a 300-kW(e) thermionic space reactor using full-length external-fuel converters is summarized. The design is characterized by zoned-fuel converters oriented horizontally in the normal launch configuration in order to reduce shadow-shield weight. The converters are arranged on a rectangular grid, supported by a structural box which is bolted to the vehicle frame. Among the more significant features of the design are: no high-voltage tri-layer sandwich insulator within core; low maximum fuel temperature; structure and converters capable of withstanding most severe launch loads and space accelerations; and negative reactivity coefficient due to fuel expansion. Both liquid-metal and heat-pipe cooling are feasible without basic alteration of the core design. Liquid-metal cooling makes it possible to completely eliminate the tri-layer insulator from the design. Heat-pipe cooling offers the ultimate in modularity and pre-test capability, permitting reactor assembly of complete modules without subsequent welding or brazing. 14 references. (auth)

2025 (TID-24818, pp 49-56) ZrH_x THERMIONIC SPACE POWER SUPPLIES. Anderson, R. C.; Frank, T. G.; Salmi, E. W. (Los Alamos Scientific Lab., NM). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A study of space power supplies based on the use of ZrH_x-

moderated thermionic reactors is reported. Reactor designs including fueled moderators as well as pure ZrH_x moderators, were studied. The reactor concept is elaborated by a detailed description of a 50 kW(e) design. This design is generalized to include electric power levels from 25 to 150 kW. Weight estimates for all system components for shielded and unshielded space power supplies are given. (auth)

2026 (TID-24818, pp 57-66) ALTERNATIVE DESIGNS FOR LOW POWER THERMIONIC REACTORS. Mathews, D. R.; Cohen, S. C. (Gulf General Atomic Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The relative advantages and disadvantages of several alternative approaches to the design of thermionic reactors in the 20 to 300 kW(e) power range have been examined. The approaches which will be discussed include: methods for increasing the fuel volume fraction; addition of moderating materials; inclusion of moderated or unmoderated driver regions; and use of fuels containing U−233 or Pu−239. The comparisons include the sizes, weights, thermal and electrical power outputs, and fast neutron fluxes and are based upon multigroup one- and two-dimensional criticality calculations. 11 references. (auth)

2027 (TID-24818, pp 67-76) EVALUATION OF THERMIONIC REACTOR DESIGN CONCEPTS IN THE 50 TO 1000 kW(e) RANGE. Sawyer, C. D. (General Electric Co., Pleasanton, CA); Robertson, C. S. Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Four alternative means of achieving a 50 to 100 kW(e) thermionic space power plant were considered. In the first of these, the thermal power level of a 200 kW(e) reactor design was reduced, thus derating the thermionic output. The second considered the use of an alternative fissile isotope, U−233, to circumvent the criticality constraint. The third alternative sought to circumvent the criticality problem by providing a nonelectricity producing driver fuel in addition to thermionic fuel elements. The fourth alternative considered a moderated reactor employing zirconium hydride. The studies included an examination of the entire power plant to determine the influence of reactor efficiency and reactor size on plant weight. The results of these analyses indicate a weight performance advantage only for the use of the alternative fissile isotope U−233. For the other cases, the trade-offs provided by the influence of reactor efficiency and reactor size indicate no clear performance advantage. 4 references. (auth)

2028 (TID-24818, pp 77-86) THERMIONIC POWER PLANT DESIGN FOR ELECTRICALLY PROPELLED, MANNED SPACE VEHICLES. Gietzen, A. J. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A design for a thermionic power plant with a minimum capability of 3 MW(e) for a design life of 10,000 hours is presented. Excess capacity is incorporated into the electrical and thermal systems to compensate for failures in order to attain a system reliability of 0.999. The reactor design utilizes unit cell fuel elements arranged on a triangular pitch to form a reactor layer. Waste heat is removed from the core by small rectangular ducts in which the fluid flows perpendicular to the fuel element axis. The heat rejection system includes primary and secondary loops with intermediate heat exchangers and a radiator composed of many heat pipes. The power plant is subdivided into 32 independent modules, each containing a ½-layer segment of the reactor, independent coolant loops, and a segment of the radiator. Each of these modules can be completely assembled at the fabrication facility and pretested by electrical heating of the emitters prior to loading the fuel and assembly of the complete system. Design details describing the reactor, shield, heat rejection system, and power conditioning system are presented. 5 references. (auth)

2029 (TID-24818, pp 98-102) THERMIONIC REACTOR SYSTEM WITH SINGLE UNINSULATED COOLANT LOOP. Schock, A. (Fairchild Hiller Corp., Farmingdale, NY). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

In thermionic reactors employing external-fuel full-length diodes the collector-to-coolant insulator is not exposed to cesium, and can in fact be entirely removed from the reactor core and its deleterious fast neutron flux. As previously recognized, this can be done by employing many coolant loops, each with its own pump duct, operating at different electrical potentials. The tri-layer insulator can be completely eliminated even with a single, uninsulated coolant loop, by letting the radiator and associated plumbing act as a controlled current leak. An illustrative example demonstrates that the resultant power loss is insignificant, and that in contrast to the usual pump requirement, the proposed arrangement calls for a relatively high pressure drop, but at a very low flow rate. Finally, it is shown that a minor modification of the hydraulic circuit permits operation of the coolant pump at an arbitrarily low temperature; e.g., a little above the melting point of sodium or NaK. Under these conditions, it may be preferable to employ high efficiency mechanical pumps in place of the usually proposed electromagnetic pumps. 4 references. (auth)

2030 (TID-24818, pp 103-114) THERMAL, ELECTRICAL, AND MECHANICAL PERFORMANCE CHARACTERISTICS OF A NUCLEAR HEATED THERMIONIC CONVERTER CELL. Wilkins, D. R.; Peterson, G. A.; Lloyd, W. R.; Hill, P. R. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A digital computer program developed to describe the flow of heat and electricity throughout a nuclear heated, cylindrical thermionic converter cell is described. The distributions of heat flow, temperature, electrical current flow and potential throughout the cell are presented and discussed for typical cell operating conditions. The computed cell temperature distributions are employed as input to a second digital computer program which yields thermal stress distributions throughout the converter cell. Stress distributions are also presented and discussed for typical cell operating conditions. Implications of the computed results with regard to cell performance, performance interpretation and long-term cell integrity are brought forth. 7 references. (auth)

2031 (TID-24818, pp 138-155) OPTIMAL POWER FLATTENING IN CRITICALITY BOUND THERMIONIC REACTORS. Sawyer, C. D.; Hill, P. R. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A computational method is presented which was developed to determine the optimum electric power level of a given reactor configuration taking into account the complex interaction between criticality, power distribution, fuel loading distribution and the fuel temperature constraint. The application of this technique to a reactor concept containing TFEs for application in the 300 to 400 kW(e) range is discussed at length. 4 references. (auth)

2032 (TID-24818, pp 156-163) FUEL ZONING: FUEL VOLUME FRACTION VS ELECTRICAL POWER OUTPUT. Homeyer, W. G.; Mathews, D. R. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The effect of fuel zoning in a thermionic reactor on the electrical power output and efficiency of the cells in the reactor has been analyzed. Thermal power distributions calculated with two-dimensional transport theory were converted to electrical power distributions with the help of a computer program. This program employs curves of electrical output and emitter temperature vs thermal input at constant current and constant cesium pressure. The power output was calculated for an unzoned reactor, and for cores with intermediate zoning. Intermediate zoning schemes were selected to maximize both the average fuel volume fraction (with a fixed maximum fuel volume fraction) and the electrical output (with a fixed maximum emitter temperature). It was found that a fully zoned reactor had about twice the power output and about 80% of the fuel volume fraction of an unzoned reactor. Intermediate zoning was shown to be generally more desirable than the two extremes, since large gains in power output could be made with a small reduction in the fuel fraction. (auth)

2033 (TID-24818, pp 164-169) IN-PILE TEST OF CONVERTER WITH NONVENTED FINNED EMITTER. Scott, J. M.; Samstad, G. I. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Fission product accommodation through the containment of the the fission products within the fuel and emitter is being investigated. The central temperatures and temperature gradients in the UO_2 fuel can be reduced by the use of internal metallic fins. Trial use of such a finned emitter has been made in SCIP 512 and a second trial is in SCIP 518. Design features and test results will be discussed. 7 references. (auth)

2034 (TID-24818, pp 177-183) THERMIONIC FUEL ELEMENT DEVELOPMENT STATUS. Street, G.; Holtslag, D. J.; Samstad, G. I. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The Thermionic Fuel Element (TFE) consists of a number of nuclear fueled cylindrical thermionic converter cells connected in series electrically to form a reactor fuel rod. In a continuing development program, several prototypical TFEs have been fabricated and successfully tested. These TFEs consist of three closely spaced series connected cells with each cell composed of a UO_2 fueled tungsten emitter, niobium collector, alumina insulator and Kovar or Ceramvar outer sheath. The evolution of the design and fabrication of these TFEs is presented. A detailed discussion of the recent operating characteristics and life test operation is included. 4 references. (auth)

2035 (TID-24818, pp 184-193) OPERATION OF IN-PILE CONVERTERS WITH GAS PORT AND SORBENT PUMP. Holtslag, D. J. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A continuing program is being conducted by General Electric to develop means for handling fission gases in a thermionic reactor. Results obtained during the past year are presented. Histories of one single cell and three multi-cell in-pile converters are described. Each of these devices incorporates a port and sorbent pump to withdraw fission gases admitted to the diode space by vented emitters. Stable extended operation of multi-cell converters has been obtained over time periods and at output levels previously reached only by single cell devices. This accomplishment is attributed in large part to the port and sorbent pump system. (auth)

2036 (TID-24818, pp 194-211) POST-IRRADIATION EXAMINATION OF THERMIONIC CONVERTERS. Danko, J. C.; Holtslag, D. J.; Gelhaus, F. F. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The results of post-irradiation analysis of four single cell in-pile converters (SCIP) and two 3-cell thermionic fuel elements (TFE) of the one-inch reference design are presented. All of the SCIP's and TFE's had chemical vapor-deposited (CVD) tungsten emitters and bulk UO_2 fuel. Two SCIP's were instrumented with emitter thermocouples (one SCIP had a vented emitter), one was unvented and one SCIP, the first of a series, was vented with the fission gases ported to a charcoal sorbent pump. All of the SCIP's had nickel collectors. The TFE's had niobium collectors and one TFE had vented emitters. 5 references. (auth)

2037 (TID-24818, pp 212-221) LONG TERM OPERATION OF FISSION HEATED CONVERTERS. Yates, M. K.; Schwarzer, D. E.; Holland, J. W. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Six cylindrical thermionic converters including three fuel elements were tested in-pile to determine performance levels and long term performance stabilities. Three of the converters were fueled with uranium oxide and three with uranium zirconium carbide. All of the converters employed tungsten emitters vapor deposited from WF_6. The three fuel elements used niobium for the collector; the rest used molybdenum. Among the converters not compact enough to be classified as thermionic fuel elements, one test (Mark VI IC-UO_2) ran stably for 5369 hours at an average electrode power density of 10 W/cm^2. The other two tests (Mark VI IC-I3 and Mark VI IC-J1) have run 4308 and 2218 hours to date at average electrode power densities of 6 and 7 W/cm^2, respectively. Among the three fuel elements tested, two were of the Mark VIIA series with 0.625 inch diameter emitters. The Mark VIIA, IC-D1 and IC-D2, were operated for 728 hours at 7 W/cm^2 and 2006 hours at 6 W/cm^2, respectively. Another test designated as Mark VIIB IC-C1 (1.1 inch emitter diameter) operated for 1496 hours at 7 W/cm^2 electrode power density. 4 references. (auth)

2038 (TID-24818, pp 222-231) POST OPERATIONAL EXAMINATIONS OF THERMIONIC CONVERTERS. Horner, M. H. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Post operational examinations were conducted on two in-pile, UO_2 fueled, converters. The tests ran for 5300 hours for a converter of Mark VI design and for 2006 hours for a fuel element of Mark VIIA design, respectively. Post operational examinations were performed by visual examination, metallographic analyses, leak tests, dimensional measurements and gamma scanning. Changes in titanium getter ring geometry caused the interelectrode short which terminated the Mark VI diode test. A fuel cladding interaction was observed but emitter dimensional changes were slight. An interelectrode short related to emitter dimensional change caused termination of the Mark VIIA fuel element test. The emitter dimensional change was found to be caused by the geometry of a thermocouple well spacer clip and by the failure of a fission product chamber venting mechanism to function correctly. Converter envelopes remained intact and in excellent condition. 9 references. (auth)

2039 (TID-24818, pp 232-239) DESIGN OF AN IN-PILE TEST OF A CLUSTER OF SIX THERMIONIC FUEL ELEMENTS. Fisher, C. R. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The preliminary design of an in-pile test capsule containing six thermionic reactor fuel elements is described. The test design is based upon irradiation in a Hanford Production Reactor. The assembly to be tested is a segment of the core of a thermionic reactor based upon the unit cell multiple layer-pancake concept. The design incorporates six, independent, liquid-metal coolant loops for redundancy in the coolant function. The fuel element embodies the features of a reactor experiment prototype including refractory-metal, intercell electrical lead, short emitter stem region, and metallurgical bonding to the reactor structure. The reactor structure uses the ribbon duct-heat pipe coolant geometry. (auth)

2040 (TID-24818, pp 240-255) POST IRRADIATION EXAMINATION OF SD-4 INPILE DIODE. Speidel, T. (Thermo Electron Corp., Waltham, MA); Howard, R. C.; Speidel, E. O.; Saling, J. H. Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The SD-4 diode was removed from the BMI reactor after 8120 hours of operation when the diode coolant lines became clogged. The results of the hot cell examination performed at Battelle Memorial Institute are presented. These results compare the inpile diode SD-4 and the electrically heated SD-2. Dimensional stability, extent of fission gas release, fuel stability and condition of diode components are discussed. (auth)

2041 (TID-24818, pp 267-274) IRRADIATION OF W-25 w/o Re CLAD UO_2 SPECIMENS. Part I. Design, Fabrication and Operation of the Irradiation Experiment. Gregory, T. L. Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A fueled irradiation capsule was designed, fabricated and tested in the NASA Plum Brook Reactor. The experiment was performed to determine the fission gas disposition and dimensional behavior of bulk UO_2 fuel specimens clad with tungsten-25 w/o rhenium in a configuration representative of a nuclear thermionic fueled emitter. The capsule consisted of four specimens. Each specimen had three 0.020-inch holes in the end cap to allow for fission gas venting. The temperature of the specimens was sensed by two thermocouples located in the specimen stem. Control of the experiment was based on adjusting specimen location to maintain a temperature of 1650°C. The fuel was irradiated to a maximum burnup of 2.16×10^{20} fissions/cc. (auth)

2042 (TID-24818, pp 275-290) IRRADIATION OF W-25 w/o Re CLAD UO_2 SPECIMENS. Part II. Post-Irradiation Examination of the Experiment. Danko, J. C.; Mondt, J. F. Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Examination was performed on four irradiated W-25 w/o Re clad UO_2 specimens. Two specimens were irradiated to a fuel burnup of 2.1×10^{20} fissions/cc and the other two to a burnup of 1×10^{20} fissions/cc. Post-irradiation examination consisted of neutron radiography, fission gas analysis of the specimen container, dimensional measurements of the specimens, fission product distribution, fuel burnup, O/U measurements, fuel loss through the vent holes and metallography. Based on these examination results and the operating history, a mechanical interaction between fuel and clad is proposed to explain the dimensional changes. (auth)

2043 (TID-24818, pp 291-299) DESIGN, FABRICATION, AND IRRADIATION OF W-CLAD/UO_2 FUEL CAPSULE. Allen, D. C.; Gregory, T. L.; Sawyer, C. D.; Lloyd, W. R.; Kroeger, E. W. Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

A fuel irradiation capsule consisting of two specimens, each containing a bulk uranium dioxide (UO_2) fuel pellet clad with chemical vapor deposited, 0.030-inch-thick tungsten, was de-

signed and fabricated. The lower clad end cap in each specimen contains a 0.010-inch-diameter vent hole for the escape of fission gases. The temperature of each specimen fuel cladding is sensed by: (1) a special high temperature W–Re thermocouple located in the upper clad end cap, and (2) two medium-range temperature chromel/alumel thermocouples located in the support stem of the fuel/clad specimens. The capsule is currently being irradiated in the NASA Plum Brook Reactor. Initial test results with a clad temperature of 1650°C show evidence of fuel redistribution as determined by the comparisons of the high and low temperature thermocouple readings. 5 references. (auth)

2044 (TID-24818, pp 300-312) IRRADIATION STABILITY OF Mo 40v/o UO_2 THERMIONIC REACTOR FUEL. Ranken, W. A.; Patrick, A. J.; Chaney, M. C. (Los Alamos Scientific Lab., NM). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Irradiation has been completed on a set of fifteen 0.25 in. diameter cylindrical specimens of Mo 40v/o UO_2 cermet clad with ~0.005 in. of CVD tungsten. The specimens were contained in four test capsules irradiated in the MTR for 2297, 3245, 6113 and 10,400 h with corresponding fission densities in the fuel specimens ranging from 9.2×10^{19} to 3.7×10^{20} fissions/cm^3 of cermet. Specimen temperature during irradiation was approximately 1750°C and the mean power density in the fuel was ~280 W/cc. Measurements have been made on diametral increase, fission gas release and fuel porosity changes. The results of these measurements are presented and their significance relative to the design of fueled emitters for thermionic reactors is discussed. 8 references. (auth)

2045 (TID-24818, pp 314-323) IMPROVED BURNUP CAPABILITIES OF CERMET FUELS BY INCREASES IN VOID FRACTION. Newsom, D. L.; Collins, J. F. (General Electric Co., Cincinnati). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The service capability of W-UO_2 cermet fuels was improved by increasing the void fraction of the fuel core. Burnup to 2×10^{20} fissions/cm^3 of cermet was achieved at surface temperatures of 1600°C with complete containment of fission products. Four tungsten alloy clad W-UO_2 single channel specimens with cores 88 percent of theoretical density were irradiated for 3335 hours and incurred nineteen thermal cycles. The increased void fraction of the cermet fuel core provided greater capacity for storage of fission gases and thereby doubled the leak-free life in terms of burnup capability shown by any previous in-pile test. The fabrication procedure for low density clad cermets, the in-pile test operational history and the post-test evaluations are presented. A non-nuclear test which simulated the thermal history of the irradiated specimen provided comparative data to isolate the effect of irradiation on fuel stability. 4 references. (auth)

2046 (TID-24818, pp 324-333) STUDY OF THE STABILITY OF OPEN PORE STRUCTURES IN POROUS UC–ZrC. Hudson, R. G.; Horner, M. H.; Creagh, J. W. R.; Yang, L. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The usefulness of UC-ZrC as a thermionic fuel may depend upon the presence of open pore structures in the fuel body to promote fission gas release and thereby minimize fuel swelling. Stability of such open pore structures at high temperatures is therefore of primary concern. Isothermal furnace testing results are presented in the form of change of true surface area to geometric surface area ratio as a function of time in the temperature range 1600-1900°C, using UC-ZrC samples prepared by isostatic cold pressing and sintering from powders of various size fractions. Addition of 4 wt% of tungsten to the fuel samples was found to have a significant effect in increasing the true surface area to geometric surface area ratios of UC-ZrC fuel samples, both in the as-prepared state and after long periods of time at high temperatures. The significance of these results are discussed from the point of using UC-ZrC as thermionic fuel material. 6 references. (auth)

2047 (TID-24818, pp 365-372) SHEATH INSULATOR INVESTIGATIONS. Chin, J.; Messick, C. W. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Materials and processes for preparing sheath insulators for unit cell thermionic diodes are being evaluated. Brazing, vapor deposition, and gas pressure bonding techniques for fabricating sheath insulators are compared. Quality of the insulators are judged by joint uniformity, ceramic integrity, metallography, microhardness, impurity measurements, microprobe examination, thermal shock tests, thermal stability tests, and resistivity measurements. Copper brazed insulators were difficult to prepare, had non-uniform joints, and were temperature limited. Differential bonded vanadium-niobium brazed insulators which overcome most of these problems are now being evaluated. Chemically vapor deposited sheath insulators had high impurity contents which in some specimens caused electrical shorts in the insulator. Test samples which were good insulators at room temperature met minimum resistivity requirements at 800°C in spite of numerous observed cracks in the ceramic. Gas pressure bonded sheat insulator test specimens were uniform, had low impurity contents, did not have observed cracks in the ceramic and met minimum resistivity requirements at 800°C. Preparation of 0.010 in. thick alumina gas pressure bonded sheath insulators for thermionic test cells is questionable because of relative thicknesses of the proposed niobium and alumina layers. Resistivity measurements of all insulators were found to be a sensitive function of electrical leakage around insulator ends. Techniques for applying electrical leak stoppers to the ends of the sheath insulator are reported. 9 references. (auth)

2048 (TID-24818, pp 373-378) ELECTRICAL RESISTANCE MEASUREMENTS AND DEVELOPMENT OF TRI-LAYER COLLECTORS FOR EXTERNALLY HEATED CYLINDRICAL CONVERTERS. Wolk, B.; Raiklen, H. (Fairchild Hiller Corp., Farmingdale, NY). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968.

The fabrication of the tri-layer collector is reviewed briefly and its electrical resistance data at 800°C as a function of time and applied d.c. voltage over discrete regions of the full length are reported. While these collectors appear to be structurally satisfactory and exhibit excellent heat transfer after extensive thermal cycling they do not meet the electrical resistance requirements of the program. The data indicate the desirability of eliminating Nb vapor deposition procedures to minimize contamination of the alumina layer as a means for improving and stabilizing the electrical resistance characteristics. A revised fabrication method involving gas pressure bonding a niobium sheath to the alumina coated coolant tube before electrodepositing the outer niobium collector layer is described and the resulting improved electrical resistance measurements are reported. (auth)

2049 (TID-24818, pp 379-389) FABRICATION AND CHARACTERIZATION OF OUT-OF-PILE THERMIONIC CONVERTERS WITH STABLE PERFORMANCE. Kay, J.; Horner, M. H. (Gulf General Atomic, Inc., San Diego, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Procedures have been developed for the fabrication of out-of-pile thermionic converters used in life tests. All converter components were bulk baked out and effective vacuum emitter work function and emitter temperature profiles determined prior to assembly. Converter assembly was accomplished by remote assembly techniques followed by a final bakeout before pinch-off. A residual gas analyzer was used to monitor bulk bakeout progress and to examine gases issuing from the converter and exhaust tabulation during assembly and during post assembly bakeout. Processing and characterization data are presented for two unfueled converters designated LC-7 and LC-9 which were fabricated using the described techniques. LC-7 exhibited stable performance for 3672 hours before the test was terminated because of a leak in the converter envelope. LC-9 is still under test and has accumulated 14000+ hours of stable operation. 5 references. (auth)

2050 (TIM-698) URANIUM MONONITRIDE–NIOBIUM CERMET FUEL: STATUS REPORT. Miller, A. D.; Craig, R. A. (Pratt and Whitney Aircraft, Middletown, Conn. (USA). Connecticut Advanced Nuclear Engineering Lab.). 27 Jul 1961. Contract AT(30-1)-2789. 24p. Dep. NTIS $4.25.

Declassified 12 Sep 1973.

Potential liquid cooled reactor applications directed the program to the UN–Nb or Nb alloy dispersion system. Methods were developed for the preparation of high quality UN powder and for consolidation of Nb–33 vol% UN bodies by a unique resistance "sinter-pressing" technique, utilizing a commercial three phase resistance welding machine. Thermal stability of high density "sinter-pressed" compacts was found to be good to temperatures up to 3400°F. Other tests showed that the Nb–UN cermet was compatible with lithium at temperatures up to 2200°F for times up to 250 hours. Preliminary irradiation evaluation of fuel pellets clad with a Nb–1% Zr alloy showed no swelling or other physical changes and negligible fission gas release at burnups of 0.9 and 1.4 at.% ^{235}U with calculated surface temperatures of 1700°F and centerline temperatures of 2150°F. These tests were made with He-filled fuel pins in which the pellets were loosely fitted in the

tube cladding. Preliminary fabrication studies have demonstrated the feasibility of achieving complete metallurgical bonding, pellet to pellet, and pellet to clad, by means of isostatically pressing the fuel pin assembly. (17 figures) (auth)

2051 (UCRL-6941) PLUTO PROGRAM. Meeting of the Joint ARS/ANS/IAS Nuclear Propulsion Conference, Monterey, August 15–17, 1962. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jun 1962. Contract W-7405-eng-48. 318p. (CONF-620805-). Dep. NTIS $18.00.

The Pluto Program for the development of a nuclear ramjet engine is summarized. Topics discussed include Tory II-A, Tory II-C, Tory III, investigations of ceramics and other materials, criticality measurements, and test facilities. (JWR)

2052 (Y-EB-36) PHOEBUS 1B STUDIES INTERIM REPORT. Van Hull, A. K.; Smith, R. D. (Oak Ridge Y-12 Plant, Tenn. (USA)). 6 Sep 1967. Contract W-7405-eng-26. 44p. Dep. NTIS $5.25.

Declassified 17 Apr 1974.

Statistical analysis of the Phoebus 1B data reveals that weight losses of fuel elements during reactor operations are closely related to their weight gains during coating and the extrusion press pressures used in their fabrication. Incremental internal weight losses of the elements are related to coating thickness and press pressure. On-going work is directed at determining optimum press pressures and coating thicknesses to minimize weight losses using the incremental data. (auth)

2053 (Y-EB-37) NRX-A6R PREDICTION REPORT. Van Hull, A. K.; Smith, R. D. (Oak Ridge Y-12 Plant, Tenn. (USA)). 27 Oct 1967. Contract W-7405-eng-26. 44p. Dep. NTIS $5.25.

Declassified 17 Apr 1974.

Predicted weight losses have been computed for the NRX-A6R reactor element-by-element. The basis for these predictions in the experience of the Phoebus 1B reactor. Thus, the predictions inherently contain the assumptions that the reactor will run for one-half hour and that the reactor operating parameters will be the same as those of Phoebus 1B. Although the predictions indicate the NRX-A6R elements to be somewhat superior to the Phoebus 1B elements, it is considered improbable that NRX-A6R will run for one hour if the predictive model used is valid. (auth)

2054 FUEL ELEMENT FOR A NUCLEAR REACTOR OF THE PASSIVE METHOD HYDRIDE CONTROL TYPE. Magladry, R. E. (to Teledyne, Inc.). US Patent 3,793,144. 19 Feb 1974. Filed date 30 Jul 1969. 12p.

A fuel element is described for a nuclear reactor of the passive metal hydride control type. It comprises a porous pellet of zirconium hydride and uranium of hexagon or other shape thereby permitting assembly into a closely packed system. The porous pellet has a coolant tube extending longitudinally therethrough with a ceramic, glass or enamel layer on the side of the tube contacting the fuel. (Official Gazette)

2055 PROGRESS OF JOINT EVALUATION STUDY BY JAPAN AND GERMANY CONCERNING NUCLEAR CONTAINER SHIPS. Kinoshita, M. (Hitachi Shipbuilding and Engineering Co. Ltd., Osaka). Zosenkai; No. 39, 8-18(Aug 1972). (In Japanese).

Expectations of the materialization of really economical nuclear ships have grown rapidly in shipping and shipbuilding industries in recent years. Those concerned with nuclear ships in Japan and Germany conferred several times on the joint examination of economy, research, development, construction and operation of the nuclear ships, and decided in 1970 to execute an evaluation jointly on the technical and economical problems of nuclear container ships. Since then, trial design and economical evaluations have been carried out jointly for 14 months. The container ship studied was an 80,000 hp full container ship being used for Europe-Far East route via Panama at present, and this ship was designed as a nuclearized ship. As a nuclear reactor for the ship, a pressurized water reactor of the EFDR type was adopted. The advantages of the nuclear ship cannot be utilized fully unless especially heavy cargos are collected, because considerable surplus arose in mean cargo weight per container. Double hulls and triple bottoms were adopted around reactor compartments. Two cross-compound steam turbines with double reduction gearing, each developing 40,000 hp, and twin propellers were used. Thermal output of the reactor is 220 MW. The core comprises 24 fuel elements containing about 8.7 tons of uranium oxide, and the enrichment rate is 3.7%. The operational economy of the nuclear ship was compared with that of a conventional container ship, and the nuclear ship is economically competable under some conditions. Technical, legislative, and other problems are discussed. (JA)

2056 UNDERWATER OPERATING THERMIONIC GENERATORS. Alleau, T. (CEN de Saclay, Gif-sur-Yvette); Sassy, C. C. Rev. Gen. Elec.; 82: No. 9, 552-555(Sep 1973). (In French).

From meeting on nuclear thermionic generators; Marseille, France (26 Oct 1972).

The possible sources of energy suitable for operating underwater equipment are examined. The use of nuclear thermionic generator is considered with the cases of a fixed low power generator and a high powered generator suitable for propulsion being examined. (FR)

2057 FEDERAL LAW CONCERNING THE TREATY BETWEEN THE REPUBLIC OF LIBERIA AND THE FEDERAL REPUBLIC OF GERMANY ON THE USE OF LIBERIAN WATERS AND PORTS BY N. S. OTTO HAHN. Bundesgesetzblatt, Teil 2; No. 34, 953-962(1971). (In German, English, and French).

The full text of the treaty is given in English and German. (GE)

2058 NUCLEAR ENGINE REACTOR ROCKET CORES. Moon, C. W. (to Secretary of the Air Force). US Patent 3,793,832. 26 Feb 1974. Filed date 23 Jul 1968. 10p.

A nuclear rocket engine reactor core is described which is equipped with a series of coolant channels having hydraulic diameters that decrease in programmed proportion with increasing radial position from the core center to reduce the required propellant coolant flow to a minimum during the aftercooling period occurring after reactor shutdown. (Official Gazette)

2059 ANALYSIS OF ZERO ENERGY EXPERIMENTS FOR THE SECOND CORE OF THE OTTO HAHN. Buenemann, D. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht-Tesperhude, Ger.); Justin, J.; Siewers, H.; Mueller, E. Atomkernenergie; 22: No. 3, 155-158(Dec 1973). (In German).

The theoretical methods for reactor core calculations applied to the critical experiment of the second core of the "Otto Hahn" are described. The analysis and interpretation of the experiment demonstrates that a satisfying accuracy of theoretical predictions is obtained. (GE)

2060 THERMIONIC CONVERTER FOR NUCLEAR REACTOR. Schutt, P. F. (to Babcock and Wilcox Co.). Canadian Patent 904,452. 4 Jul 1972.

A thermionic converter for generating electric power has a cylindrical cathode enclosed by a cylindrical anode, which is itself enclosed by a cylindrical container. The space between the cathode and anode contains alkali metal vapor, preferably cesium. The novelty of the invention consists in filling the outer space with a gas (preferably noble) at controlled pressure; the gas may occupy the interstices in a porous filling such as graphite foam or ceramic powder. By controlling the gas pressure, the output voltage of the converter is controlled. The converter may be situated inside the core of a nuclear reactor, in which case the cathode contains nuclear fuel, and the outer container is cooled by primary coolant. Alternatively, the converter may be outside the core, in which case the cathode is heated by primary coolant, and the outer container is cooled by air (it may be finned), or by secondary coolant. (CA)

2061 COMMISSIONING OF THE SECOND CORE OF THE FDR. Brodale, V.; Kolb, M.; Robinson, E.; Schwieger, E.; Voeltzer, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht-Tesperhude, Ger.). Atomkernenergie; 22: No. 3, 165-168(Dec 1973). (In German).

The commissioning of the N. S. Otto Hahn reactor with the second core is described. Results are presented for the first nuclear start-up, the measurement of the isothermal temperature reactivity coefficient, the selfregulating properties, the load change transients, and the switching of one of the three primary coolant pumps. (GE)

2062 MEASUREMENT OF LARGE SHUTDOWN AND EXCESS REACTIVITY VALUES WITH THE PULSE NEUTRON SOURCE TECHNIQUE. Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht-Tesperhude, Ger.). Atomkernenergie; 22: No. 3, 159-164(Dec 1973). (In German).

Pulsed neutron source measurements were done on the 2nd core of the FDR, the reactor core of the nuclear ship "Otto Hahn", over a reactivity range up to 45. For calculating reactivity, the known techniques of Gozani, Garelis-Russel, Sjoestrand, Simmons-King, Kolb-Boettcher and the dependence of the prompt decay constants of the boric acid concentration were used. The last three methods give excellent agreement. Over a reactivity range of 35 the agreement with theory was excellent. The differences with theory are assumed to be due to errors in theoretical calculations. (GE)

2063 POWER EVALUATION OF THE NUCLEAR PROPULSIVE MODULE. D'Elia, G. (Univ., Naples). Termotecnica (Milan); 28: No. 1, 24-33(Jan 1974). (In Italian).

The values of the specific performance characteristics of the propulsive unit are computed, which never before have been published by unclassified literature, under the hypothesis of ideal work conditions of the reactor and assuming that the thermal problem is the most important one. In addition the weight of all components of the propulsive unit is given. (auth)

2064 CALCULATION OF PRESSURE CHANGE IN FDR TYPE REACTORS DUE TO LOAD CHANGES. Luebbesmeyer, D. (Technische Univ., Berlin). (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

A computer program developed for the Otto Hahn Reactor is described, treating subcooled boiling as well as recondensation and evaporation effects in the chimney in a two-phase model. (GE)

Reactor Safety and Environmental Aspects

Refer also to abstracts 210, 256, 301, 302, 867, 1861, 1923, 1925, 1929, 1930, 1951, 1974, 1977, 1982, 1983, and 2000.

2065 (AD-766864-3) FLOATING POWER PLATFORM CONCEPT FOR THE WEST COAST. Salter, R. G. (Rand Corp., Santa Monica, Calif. (USA)). Dec 1972. Contract N00014-69-A-0060-0003. 13p. (P-4939). NTIS $3.00.

A comparison of the reactor siting concepts for potential use off the West Coast of the United States is presented. A particular adaptation of one of the offshore concepts (the FLOPP) is described. (GRA)

2066 (CONF-720468-, pp vp Paper 9) SAFETY EVALUATION OF UNDERCLADDING CRACKS. Bartholome, G.; Dorner, H. (Siemens AG, Erlangen, Ger.). 1972.

From sixth annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Based upon both test results and theoretical analysis, it is concluded that an adequate safety margin is available against failure of nuclear components from undercladding cracks. This safety margin was evaluated as follows: 1. experimental safety program; 2. safety against undercritical crack growth; 3. safety against brittle fracture for hydrotest emergency core cooling and unrealistic, very conservative assumptions. The experimental safety program included mechanical testing of various zones, crack growth and fatigue tests, and brittle fracture tests. Results of these investigations are summarized. The growth of the undercladding cracks due to the specified cycles over the whole lifetime is shown to be negligible. The safety analysis against brittle fracture was done by means of the Pellini concept, crack instability concept, and crack arrest concept for hydrotesting and emergency core cooling conditions. Unrealistic but exceedingly conservative assumptions were made. Linear elastic fracture mechanics solutions indicate that there always exist a sufficient safety margin against brittle fracture. The calculation and the results are given in detail. These evaluations permit the conclusion that undercladding cracks have no influence on the operation and safety of nuclear power plants. (8 figures) (auth)

2067 (CONF-720468-, pp vp Paper 26) HSST FRACTURE INVESTIGATIONS: AN OVERVIEW. Witt, F. J. (Oak Ridge National Lab., TN). 1972.

From 6th annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Many investigations of the material behavior of the ASTM A533 grade B, class 1 steel and related product forms have been carried out under the auspices of the HSST program. Both experimental and analytical approaches to fracture analysis have been vigorously pursued. A paramount feature of the HSST program has been, in general, the testing of large specimens, some in thickness of 12 in. Other significant investigations have been carried out on a lesser scale. Each investigation, however, has been or is being carried out with specific programmatic objectives. Throughout the program these programmatic objectives have remained flexible and have often changed based on overall program results. Also, new results often lead to reinterpretations of data long after they were obtained. An attempt is made to review the majority of the data obtained to date by the HSST program and to cast them in the light of the most recent results, interpretations, and analyses. The overall status of the HSST program is discussed, and significant accomplishments are reviewed. (12 figures, 28 references). (auth)

2068 (HEDL-SA-646(Rev.1)) DYNAMICS OF MOLTEN FUEL MOTION DURING A FAST REACTOR OVERPOWER TRANSIENT. Willenberg, H. J.; Partain, W. L.; Waltar, A. E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Apr 1974. Contract AT(45-1)-2170. 19p. (CONF-740401-4). Dep. NTIS $4.00.

From conference on fast reactor safety; Los Angeles, California, USA (2 Apr 1974).

Fuel expulsion from the reactor core has been widely considered as a potential neutronic shutdown mechanism following a hypothetical unprotected overpower transient accident in an LMFBR system. Previous studies, however, have been of primarily a scoping nature and, as such, were based on several simplifying assumptions regarding the dynamics of molten fuel motion. The present study has been conducted to investigate the validity of some of these major assumptions. Consideration is given to explicit pressure and density variations of the fuel/gas mixture inside the fuel pin cavity during the expulsion process, the effects of cladding rupture size, the influence of the gas to liquid ratio of the expelled fuel, and the effects of spatial density variations and potential plateout of fuel once the expelled mixture reaches the coolant channel. A treatment of the internal molten fuel/gas mixture as a two-phase, compressible fluid yields a markedly different reactivity feedback than that predicted with a fluid of uniform internal density and composition, but does not appear to substantially alter previous conclusions regarding the ability of a reactor to ultimately shut down safely. Cladding rupture size was found to be unimportant, whereas the composition of the fuel/gas mixture first entering the coolant channel can significantly influence the reactivity feedback behavior. Despite rather peaked density skewing distributions postulated for fuel being swept out into the coolant channel, the overall transient behavior does not appear to vary appreciably from previous studies, so long as off-center failures predominate. Early fuel plateout does not appreciably alter the reactivity shutdown mechanism, although it may become a factor regarding long-term heat removal questions. (auth)

2069 (WASH-1308) POPULATION DISTRIBUTION AROUND NUCLEAR POWER PLANT SITES. (USAEC Directorate of Licensing, Washington, D. C.). 17 Apr 1973. 39p. Dep. NTIS $5.00.

The siting of nuclear power plants in metropolitan areas is analyzed. A proposed policy statement and regulatory guide for such siting is appended along with background information on current population siting practices. (JWR)

2070 ANALYSIS OF THE BEHAVIOR OF FISSION PRODUCT GAS IN SOLID FAST REACTOR OXIDE FUEL UNDER TRANSIENT HEATING CONDITIONS. Dias, J. W. C. Los Angeles; Univ. of California (1973). 253p. University Microfilms Order No. 73-32,057.

Thesis (Ph.D.).

The behavior of gaseous fission products in oxide fuel undergoing transient power conditions is analyzed. In particular, the work is concerned with the fuel swelling which arises from the growth of intragranular bubbles during an overpower transient. First, a detailed review of the several phenomena associated with the behavior of fission gas in fast reactor fuel is conducted. Most of the work is performed with the computer code GRASS (Gas Release and Swelling Subroutine) that has been written for inclusion in the LIFE code. Two series of calculations, one based on analysis of an unprotected fast reactor accident involving large reactivity insertion and the other an analysis of experimental observations from a TREAT transient test in a pre-irradiated fuel element which was heated to near melting, comprise the essence of these studies. Strong emphasis is given to the phenomenon of gas bubble mobility and its effect on fuel swelling, and, to this end, the experimental work is employed extensively. From the first series of studies, a conclusion is that if reasonably high stresses are attained in the fuel, fuel swelling during the course of a reactivity-insertion accident may be negligible or even smaller than that at the onset of the accident. Sensitivity analyses on the effects of bubble diffusion coefficient, temperature, hydrostatic pressure, gas generation, bubble nucleation, fission-induced gas-atom resolution, temperature gradient, grain boundaries and dislocations, duration of the transient, pretransient bubble size, and pretransient burnup on fuel swelling were also conducted. Of these,

gas generation, bubble nucleation, gas re-solution, temperature gradient, and pre-transient bubble distribution are found to have a negligible bearing on the fuel swelling. For the second series of calculations, the measurements obtained at HEDL from microscopic examination of intragranular porosity in TREAT transient tested oxide fuel are used. The tested fuel consisted of mixed-oxide (denominated PNL 1-7) pre-irradiated in the EBR-II at a linear power of 8.85 kW/ft to a burnup of approximately 0.952 at.%. The nominal instantaneous peak fuel pin power and calculated peak fuel temperature reached in TREAT were 41 kW/ft and ~2400°C, respectively. Further studies with GRASS, allowing for bubble motion, were undertaken, the results of which indicate that as temperature rises in the fuel, the process of bubble diffusion becomes much faster than if it is predicted by the current processes based on bubble-motion observations at 1400-1500°C. It is believed that ultimately bubble motion becomes surface-diffusion controlled. Meanwhile, the bubbles tend to move by surface diffusion, but do not do so on account of the motion-hindering effects due to impurities and structural defects in the lattice. As temperature goes up, the faster agitation of the lattice ions around the bubble, coupled with the possible dissociation of impurities attached to the bubble at elevated temperature, may induce forces large enough to overcome those hindering effects. Sensitivity studies assuming bubble motion becomes surface-diffusion controlled at elevated temperatures are also carried out. Except for the case of biased migration, which is found to be comparable to Brownian motion, the trends are, at least qualitatively, the same as those obtained for the hypothetical FFTF accident, in which no modification in the treatment of bubble mobility in GRASS had been made. In particular, from the sensitivity studies, the indication that the effects of neutron irradiation on fuel swelling are negligible suggests that the TREAT reactor might be replaced by an out-of-pile heating apparatus for similar further experiments. As a result of the assumption of surface diffusion for bubble motion at elevated temperature, fuel expansion due to bubble growth can be very significant. For example, using this assumption in a calculation with the theoretical data used in the previous series of calculations, fuel swelling due to the bubble growth during the transient alone reached a maximum of approximately 2%, despite fuel-stress values as high as 8000 atm. Intragranular fission-gas induced fuel swelling is thus a potential mechanism for fuel-cladding failure. (Diss. Abstr. Int., B)

2071 PREDICTION OF REACTOR COOLANT BLOWDOWN BY SIMILITUDE THEORY. Choi, D. K. Ames, IA; Iowa State Univ. (1973). 103p. University Microfilms Order No. 74-525.

Thesis (Ph.D.).

Safety studies simulating pressurized water and boiling water reactor hypothetical piping breaks were conducted in a simple 0.44 ft^3 vessel. Dimensional analysis was employed to deduce a set of dimensionless parameters and the theory of similitude was applied in order to relate these parameters to the model-prototype pair. The model was geometrically true to the prototype CSE reactor simulator vessel. Internal pressure and temperature, weight of fluid in the vessel, and void fraction of the fluid in the exit duct were measured during the blowdowns. Void fraction increased and mass flow rate decreased with orifice elevation. Comparison of the predicted values with theoretical predictions was made in the lower blowdown channel. The mass flowrates were less than the theoretical predictions. Anomalous subcooled pressure behavior was thought to be caused by air dissolved in the water. The mass loss rate in subcooled blowdowns agreed very well with published data. (Diss. Abstr. Int., B)

2072 SOME SAFETY ASPECTS OF LARGE LIQUID METAL-COOLED FAST BREEDER REACTORS. Bleiweis, P. B. Los Angeles; Univ. of California (1973). 294p. University Microfilms Order No. 73-32,659.

Thesis (Ph.D.).

Two areas of fast reactor safety research are examined. The first area deals with the use of current state-of-the-art methods to analyze and compare the responses of a typical 1000 MW(e) and two 4000 MW(e) fast reactors to coolant flow and reactivity perturbations. The second problem area deals with the development of two new models which allow angular effects to be treated in fast reactor disassembly calculations. Two 4000 MW(e), sodium-cooled, fast breeder reactors employing two enrichment zones and four enrichment zones, respectively, to permit study of the effects of radial power flattening, are designed for the first area of study presented in this dissertation. Reactivity coefficients and other nuclear characteristics of the 4000 MW(e) cores are calculated and compared with those of a typical 1000 MW(e) core. Possible differences in the accident trends, resulting from the differences in these reactivity coefficients and nuclear characteristics, are discussed. Two angular dependent disassembly models are derived for the second area of study. These models are based on the physical assumptions of the two-dimensional (r,z) VENUS-II disassembly analysis computer code. A two-dimensional (r,θ) model is derived to study disassembly in an infinitely long cylinder. Using this model, four angular dependent core configurations are studied. Variations in such things as size and position of the high power angular segments in the core are examined to determine the possibility of angular compression causing a secondary criticality. No such trends are found for the configuration studied. The second model derived is an approximate three-dimensional (r,θ,z) model. This model uses the Galerkin method (a subset of the method of weighted residuals) to solve for the accelerations, velocities, and displacements of materials during the disassembly calculations. Two-dimensional solutions are performed and weighted with functions, initially obtained from (r,θ) calculations, to find the approximate three-dimensional motions of material. An iterative method is used to recalculate new weighting functions to assure convergence. A few three-dimensional calculations are presented to determine the feasibility of the method for future, more complete work. The results indicate that angular motion, for the configurations studied, is second order compared to radial and axial motions. (Diss. Abstr. Int., B)

2073 AGR CORE VIBRATION TEST AT HUNTERSTON B POWER STATION. Hayakawa, H. (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 46: No. 3, 305-310(Mar 1973). (In Japanese).

In August 1972, a vibration test on an actual AGR core was performed at the Hunterston B power station. The test was undertaken jointly by Simizu Construction Co., TNPG, and the Southern Scotland Electric Agency to obtain basic seismic design data for the AGR being designed for Japan. The aim of the test was to find an attenuation constant of the actual core structure of graphite bricks, which is difficult to be determined theoretically, and it had been assumed as low as 1% in the conservative design performed previously. A vibration exciter was placed on the steel blocks covering the core and graphite shielding blocks. The number of the steel blocks to be clamped together was varied in three ways (12, 40 and 44). Although the maximum amplitude of vibration was limited (26.2 μ), resonance curves were obtained and the attenuation constant was determined. The resonance frequency was about 2.7 Hz, and the attenuation constant was 3.1% for 12 and 44 blocks, and 3.5% for 40 blocks, respectively. These values were compared with the values obtained from two preliminary tests: one is the measurement of natural vibration by microtremor, and the other is the measurement of free vibration initiated by man power. Agreement was fairly good (3.2% for the former and 3.1% for the latter test). The main conclusion drawn from this test was that the attenuation constant of 1% used in the previous design was fully conservative. (JA)

2074 BULLETIN OF THE INSTITUT FUER REAKTORSICHERHEIT. Issue 2/73. IRS Mitt.; No. 2, 1-35(1973). (In German).

Changes in the organization structure are summarized. Reactor safety studies presently in progress are briefly described. Significant actions of other countries in reactor safety are indicated. Publications of the Institut are tabulated. (JSR)

2075 EMERGENCY COOLING IN NUCLEAR POWER PLANTS. I. Wolf, L. (Technische Univ., Berlin). Energie; 26: No. 1, 27-29(Jan 1974). (In German).

From conference on emergency cooling in nuclear power plant: evaluation from the assessor's point of view; Cologne, Germany (8 Nov 1973).

An experts discussion sponsored by the "Institut fuer Reaktorsicherheit" (IRS), dealing with the problems of emergency cooling of BWR and PWR type reactors is presented. The main topics of the discussion can be grouped under the following heading: (a) Theoretical models and their experimental bases; (b) Reliability analyses; (c) Safety criteria. (GE)

2076 DISCUSSION ON THE PROCESS OF THERMAL INTERACTION BETWEEN MOLTEN FUEL AND COOLANT. Kottowski, H. M.; Holtbecker, H.; Randles, J.; Grossgut, W. Atomkernenergie; 22: No. 3, 177-183(Dec 1973). (In German).

From colloquium on reactor safety; Stuttgart, Germany (19 Jan 1973).

Theoretical studies of the interaction between molten materials (UO_2, Al_2O_3, Fe and Zircaloy) and coolants (Na, H_2O) have been performed to obtain guidance in the planning and interpretation of experiments and get answers to the following basic questions: Which are the main factors influencing the conversion of the thermal energy stored in the hot component into work (energy). How quickly is mechanical energy released. In an effort to answer the first question, events following contact are analyzed in detail: freezing of the hot component, nucleation of vapor, fragmentation of the hot component due to thermal stresses and condensation shocks. It is shown that in the absence of gas on the interface, the nucleation of vapor is delayed. It is demonstrated that if the hot component contains no gas, fragmentation into small particles

can occur whereas with entrained gas, particle sizes are significantly reduced. From these considerations, it is shown that the energy may be released from the hot component in several steps of vaporization and condensation, (supposing subcooled coolant and a relatively high ratio of coolant to fuel) with increasing fragmentation and energy conversion. (GE)

2077 BLOWDOWN RESULTS WITH AN ELECTRICALLY HEATED TUBE WITH INTERNAL FLOW. II. Representation and Discussion of the Experimental Results. Hicken, E.; Schueler, M.; Wegner, R. (Kraftwerk Union AG, Frankfurt am Main). Atomwirt., Atomtech.; 19: No. 2, 91-94(Feb 1974). (In German).

Kraftwerk Union is doing experimental investigations in the Kernenegieversuchsanlage Grosswelzheim to determine the behavior of light water reactors in the case of accidental loss of cooling. In order to investigate the thermo-hydraulic processes within blowdown, covering a pressure range from stationary initial conditions down to about 10 bar, the following three experimental steps are done: experiments with a tube with internal flow, 4-rod bundle experiments, and 36-rod bundle experiments. The program comprises experiments for PWR- and BWR-specific rod geometries. Data on pressure, inside wall temperatures, heat stream density, and the heat transfer coefficient as well as the critical load of the heated surface are shown. (GE)

2078 BULLETIN OF THE INSTITUT FUER REAKTORSICHERHEIT. IRS Mitt.; No. 3, 1-24(30 Sep 1973). (In German).

Activities of the Reactor Safety Commission are summarized. Reactor safety studies presently in progress are briefly described. Significant actions of other countries in reactor safety are indicated. Publications of the Institut are tabulated. (JSR)

2079 JAIF COMPILES REPORT ON THERMAL WATER PROBLEM. At. Jap.; 17: No. 6, 11-14(Jun 1973).

This report, prepared by an 11-member study group of the Japan Atomic Industrial Forum, is a compilation of recommended research topics related to the complex effects of thermal water discharges from nuclear power plants. The study selected and systematically arranged seven major and 23 minor points requiring greater in-depth research. The major points are: dispersal and mixing of discharged thermal water, interaction with oceanographic and meterological phenomena, physiology and ecology of marine life, effects on planktonic organisms of the passage through the cooling system, effects on ecological systems, and technologic improvements for the alleviation of detrimental effects. The study was undertaken by specialists and researchers from universities, marine product research institutes and electric power companies, and supplements previous investigations by the Science and Technology Agency, Environment Agency, Marine Products Agency, and the Ministry of International Trade and Industry, each from their respective viewpoints. In order to respond more adequately to the questions of local residents near nuclear power plant sites, many located on unpolluted coastal areas, there exists a dire need to expand the scope of previous studies and increase the exchange of data between domestic and international researchers. What is needed is a concerted and comprehensive investigation into the long-term effects of thermal water discharged by nuclear power plants to prevent further deterioration of our environment. (JA)

2080 THERMAL FLUCTUATIONS IN THE BODY OF WATER AFFECTED BY THE GENTILLY NUCLEAR GENERATING STATION. Dube, J.; Vaillancourt, G.; Couture, R. (Quebec Univ., Trois-Rivieres). Ingenieur (Montreal); 59: No. 288, 16-19(Mar 1973). (In French).

Short-term thermal variations were measured in the body of water affected by the functioning of the Gentilly Nuclear Generating Station. The time necessary for the water temperature to increase, decrease, and finally stabilize, was determined in relation to reactor neutron power. An infrared image of the thermal plume downstream of the station is given, as well as a chart of the isotherms in that portion of the St.-Laurence River affected by the station. (CA)

2081 NUCLEAR POWER PLANTS AND THE ENVIRONMENT. Report to Session 4. Greenhalgh, G. H. London; British Nuclear Forum (1973). 14p.

From fifth foratom congress on nuclear power plant in Europe: yesterday, today, tomorrow; Florence, Italy (14 Oct 1973).

Following a brief indication of the role of nuclear power in the generation of electricity in the UK, figures are given for seasonal load variations for the CEGB system. The electricity transmission system throughout England and Wales is illustrated. Main population centers are shown in relation to nuclear power station sites. The impact of nuclear power plants on the environment is considered in terms of the policy for radioactive waste discharge, siting, thermal effects of cooling water and landscaping. Government regulations controlling environmental aspects of nuclear power and licensing procedures are explained. The reasons for public acceptance of nuclear power are discussed. They are attributed to anti-pollution and economic factors, good public relations between CEGB and local communities, and full consultation with local authorities. (UK)

2082 SAFETY AND PUBLIC ACCEPTANCE FOR NUCLEAR POWER PLANT. Kikuchi, S. (Japan Academy, Tokyo). Nippon Genshiryoku Gakkaishi; 15: No. 4, 228-230(Apr 1973). (In Japanese).

Power generation by nuclear energy is a necessity for Japan because thermal power generation is fraught with many problems. Its public acceptance is discussed in terms of the maximum conceivable nuclear accident. The Risk Benefit Analysis, which is not much convincing at the present time, is first described. On the basis of the need for power generation, public approval is sought by efforts such as the Quality Assurance Program. In the choice of whether power generation should be augmented in general and whether by nuclear or thermal energy, nuclear power generation is the only alternative for Japan, taking into account even the possibility of the maximum conceivable accident in the future. The problem of setting limitations to the capacity of nuclear power plants to prevent occurrence of catastrophes is treated. (JA)

2083 PRESSURE FLUCTUATION SOURCES AT SINGULARITIES AND PROPAGATION IN PRESSURE FLOWS. Gibert, R. J. (CEN de Saclay, Gif-sur-Yvette, France). pp 501-535 of Recherches Actuelles et Applications Industrielles. Paris; Eyrolles (1973). (In French).

From fluid mechanics summer school; Ermenonville, France (4 Sep 1972).

Reactor cooling circuits can be the origin of vibrational phenomena generated by random fluctuations of the fluid pressure at the walls. These phenomena can lead to the excitation of mechanical resonances in the structures and produce ruptures. Experimental investigations were made of the nonstationary effect developing at the position where the circuit widens (singularity) which can be transmitted to the rest of the circuit. The experiment is described. The investigations revealed that the random pressure fluctuations developed by the singularity are of two types. In the case of local fluctuations downstream from the singularity, simple laws were established involving characteristic adimensional parameters. In the case of remote acoustical fluctuations which permit the amplification to be calculated at every point of the circuit, the calculations are more difficult and have not yet been effected. (FR)

2084 OPERATOR'S COMPENSATION LIABILITY INSURANCE FOR NUCLEAR SHIP MUTSU. Hozumi, N. (Nippon Fire and Marine Insurance Co. Ltd., Tokyo). FAPIG (Tokyo); No. 68, 258-262(Feb 1973). (In Japanese).

Upon loading of nuclear fuel into the reactor of N.S. Mutsu on September 4, 1972, contract of the operator's compensation liability insurance was made by the Japan Nuclear Ship Development Agency (owner of the ship) with 19 original property insurance firms in Japan, for the insurance of 6,000 million yen for the period up to March 31, 1973. The Brussels treaty (on the nuclear-ship operator liability) is first outlined; and nuclear damage compensation system for the Mutsu and other property insurances taken by the Agency are described. Description of the (Mutsu's) liability insurance includes range of responsibility by the insurance firms, share by the firms in respect to other insurances, etc. (JA)

2085 REACTION OF SODIUM WITH URANIUM-PLUTONIUM OXIDE AND URANIUM OXIDE FUELS. Blackburn, P. E. (Argonne National Lab., IL). pp 393-410 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behavior and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

The investigations include: identification of the reaction product; thermodynamic properties of the reaction product; phase and equilibration studies. The product of the reaction between UO_{2+x} and sodium is Na_2UO_4 and between U-Pu oxide and sodium is $Na_3U_{1-y}Pu_yO_4$. The thermodynamic studies of Na_2UO_4 were used to calculate the O/M ratio of the fuel and oxygen concentration of the sodium. These calculations are compared to the results of measured fuel O/M ratios and sodium oxygen concentrations in equilibrium with $Na_3U_{1-y}Pu_yO_4$. (9 figures, 20 references) (auth)

2086 THERMODYNAMIC STUDIES OF THE SODIUM FUEL REACTION AT GENERAL ELECTRIC. Adamson, M. G.; Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, CA). pp 411-420 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974).

From panel on the behavior and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Available thermodynamic information for the equilibrium system sodium (l) + sodium–fuel compound + unreacted fuel is critically reviewed. Results are interpreted primarily in terms of the equilibrium oxygen concentration in sodium (C_0) and the oxygen potential ($\Delta\bar{G}_{O_2}$) of the remaining fuel phase. Results of series of isothermal and nonisothermal capsule tests performed at General Electric are presented and an alternative experimental approach utilizing a high temperature emf cell is also described. Vanadium wires were used to determine C_0 in the isothermal tests. Although there is significant scatter in the vanadium wire results, practically all the C_0 values fall within the range 0.1 to 1 ppM (oxygen by weight) between 700 and 850°C. When expressed as oxygen potentials, these data are considerably more negative than ΔG_{O_2} values obtained either from determinations of the O/M ratio of the unreacted fuel phase or calculations based on the known free energy of formation of Na_2UO_4. Unusual kinetic features of the sodium–fuel reaction are suspected as a possible cause of this discrepancy, but there is also some doubt concerning the validity of the thermodynamic approximations used to describe dilute solutions of oxygen in sodium. (auth)

2087 SPRAY AND VENTILATING SYSTEMS OF REACTOR CONTAINMENTS IN USA NUCLEAR POWER PLANTS WITH PWR-TYPE REACTORS. Antipin, A. N. (comp.). At. Tekh. Rubezhom; No. 4, 20-25(Apr 1973). (In Russian).

A supplementary shielding spray and ventilation system is required by the design standards for biological shields by the AEC. Its purpose is to reduce by condensation the pressure and temperature of the steam within the shell which is formed instantaneously during accidental release of the coolant at high pressure from the reactor and pipelines. The leakage of radioactive steam to the environment must also be eliminated by intensive pumping of the shell and then release to the atmosphere after preliminary cleansing with filters. (tr-auth)

2088 HYDROELASTIC BEHAVIOR OF THE INTERNAL STRUCTURES OF PRESSURIZED WATER REACTORS. Boulot, F. (Electricite de France, Chatou). pp 425-439 of Recherches Actuelles et Applications Industrielles. Paris; Eyrolles (1973). (In French).

From fluid mechanics summer school; Ermenonville, France (4 Sep 1972).

The damage suffered by the S.E.N.A. and S.E.L.N.I. pressurized water nuclear reactors (1968), and at Oconee (1972) demonstrates the importance of hydroelastic problems for this type of reactor. The nature of the hydroelastic problems posed is discussed: possible flow instabilities in the annular zone between the reactor vessel and the core skirting and the coupling of these instabilities with the motion of the structure. Various different types of research being undertaken are presented. The research program undertaken by the national hydraulics laboratory (L.N.H.) is presented together with a brief description of the experimental equipment used. The results obtained in the search for flow instabilities are presented. An instability phenomenon was observed which is the cause of large pressure fluctuations. The effect on this instability of certain parameters such as the number of reactor loops, the geometry, and the Reynolds' number is examined. (FR)

2089 STRUCTURAL AND LAYOUT CONSIDERATIONS FOR A NUCLEAR POWER PLANT IN A HIGH SEISMIC AREA. Mulay, J. N.; Wahl, H. W. (Bechtel Power Corp., San Francisco). Proc. Amer. Power Conf.; 35: 110-124(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The effect of high seismic ground accelerations on the structure and layout of a two-unit (1100 MW each) BWR nuclear power plant is discussed and how the technical feasibility of designing a plant for high ground acceleration can be enhanced by changing the containment concept is presented. The structural dynamic analysis was based on assumed ground accelerations of 0.4 G for the Operating Basic Earthquake, and 0.75 G for the Safe Shutdown Earthquake to determine whether it is feasible to design a plant for high accelerations. The design included the effects of the OBE and vertical accelerations due to the OBE and SSE. If it is concluded that the design needs changing, then it has to be determined if it is economically feasible to change to such a structure. The design of the mechanical and electrical equipment will likewise need changing. (MCW)

2090 DESIGN CONCEPT FOR AN UNDERGROUND NUCLEAR GENERATING STATION AT A COASTAL URBAN SITE. Fogarty, D. J. (Southern California Edison Co., Los Angeles); Laverty, B. R.; Brush, H. F.; Halligan, D. W. Proc. Amer. Power Conf.; 35: 310-324(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The concept is technically feasible, but the combination of areas requiring further research and development of uniqueness, and of AEC licensability, might well make the urban underground nuclear power plant concept economically impractical. Design for ground displacement and the seismic interaction of the massive underground structure with the surrounding soil, and technical and economical studies required in the areas of reactor safety and additional safety factors are considered. A study is presented for an 1100-MW(e) nuclear power plant in an underground structure at a southern California coastal site. (MCW)

2091 SAFETY AND ENVIRONMENTAL ASPECTS OF LIQUID-METAL FAST BREEDER REACTORS. Jarrett, A. A.; Keaten, R. W.; Lancet, R. T. (Atomics International, Canoga Park, CA). Proc. Amer. Power Conf.; 35: 328-340(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The safety design considerations of the LMFBR are: LOCA less severe—no blowdown; natural convection is sufficient for decay heat removal; large margin to boiling; system upsets may cause large thermal transients; leakage of reactor coolant has potential for pressurization and release of significant radioactivity; steam generator leaks will result in energy release; iodine released from fuel failure is retained in coolant; and unprotected transients may be severe, requiring fuel motion for eventual shutdown. The conservation of resources and the production of low-cost electricity with minimum pollution of the environment are described concerning the LMFBR. (MCW)

2092 ADVANCED DRY COOLING SYSTEM FOR WATER FROM LARGE POWER STATION CONDENSERS. Roma, C. (Univ., Rome). Proc. Amer. Power Conf.; 35: 626-637(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

Design criteria, a description, and advantages are given for dry cooling towers that would enable nuclear and thermoelectric power stations to be sited without restrictions. Requirements for the system included reliability, economical competitiveness not only with dry and wet towers, but also with open-circuit seawater plants; permission, virtually without limitation of power output and efficiency, of the use of turbines available on the market with a maximum back pressure of 5 in. Hg; and freedom from restriction regarding acoustic and environmental pollution and permit absolute freedom of siting for large power plants even with several high-output nuclear units. Its performance is high under adverse meteorological conditions. (MCW)

2093 NUCLEAR POWER PLANTS AND THE ENVIRONMENT. Gibrat, R. (Societe pour l'Industrie Atomique, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 102, 45-53(Jul 1973). (In French).

From fifth foratom congress on nuclear power plants in Europe; Florence, Italy (15 Oct 1973).

Other than the public's acceptance, serious problems are not envisaged up to 1985 for the implantation of nuclear plants in France. Research on environmental constraints tend to concern the end of the century rather than the present. The radiation risks to which the population are subjected and the limits to collective irradiation are considered. In addition, the effects of thermal pollution associated with concentrations in industrial zones and their compensation by a preservation of the natural environment are discussed together with the installation of tourist zones around such plants. The existence of a government organization responsible for legislation and authorization of sites with respect to the environment is cited. The different methods envisaged to gain the confidence of the public are reviewed: diffusion by the press of information on the absence of atmospheric pollution and the competitiveness of the plants; local experience around existing plants or envisaged plants. (FR)

2094 CALCULATION OF THE DYNAMIC BEHAVIOR OF LIQUID METAL COOLED REACTORS IN THE CASE OF COOLANT CIRCUIT FAILURES. Brosche, D.; Wahba, A. (Technische Univ., Munich). (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

Results and prediction possibilities using the nonlinear computer program NATRANS are given. The calculation model simulates the dynamical behavior of a central reactor cooling channel and two parallel channels including fuel rod, moderator and neutron kinetics, as well as the primary coolant circuit with pump and heat transfer device in the time range. (GE)

2095 ENVIRONMENTAL AND SOCIAL ISSUES OF SITE CHOICE FOR NUCLEAR POWER PLANTS. Spangler, M. B.

(Atomic Energy Commission, Washington, DC). Energy Policy; 2: No. 1, 18-32(Mar 1974).

Legislation now requires U. S. applicants for nuclear power plant construction permits to provide statements on the environmental impact of the plants. It is suggested that individual plant cost-benefit analyses could be more economic by establishing general rules through standardization of plant design. (HDR)

Reactor Theory and Calculation

2096 (AAEC/E-295) TIME DEPENDENT ^{237}Np, ^{235}U, AND ^{239}Pu FISSION RATES IN A THORIUM ASSEMBLY DURING THE INTERVAL 0 TO 200 ns USING A PULSED ^{9}Be(d,n) SOURCE. Part II. Theory. Moo, S. P.; Rainbow, M. T.; Ritchie, A. I. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1974. 23p. Dep. NTIS (U. S. Sales Only) $4.25.

Calculations are presented of the ^{237}Np, ^{235}U, and ^{239}Pu fundamental mode fission rates in a thorium assembly based on a diffusion theory code with a DB^2 leakage term. Three different thorium cross section sets derived from the ABBN set, the UKNDL68 file and the ENDF/B-II file were used in the calculations and the results compared with each other and with experimental results reported previously. The sensitivity of the instantaneous decay constant of the fundamental mode to changes in partial cross sections is investigated. 11 references. (auth)

2097 (AD-764195) SOLUTION FOR A NONLINEAR NUCLEAR REACTOR WITH NEGATIVE PROMPT FEEDBACK AND ONE-GROUP DELAYED NEUTRON. Nguyen van Minh. (Naval Postgraduate School, Monterey, Calif. (USA)). Jun 1973. 88p. NTIS $6.50.

Thesis.

The nonlinear space time neutron flux equation with negative prompt feedback and one-group delayed neutron is reduced by the use of a nonlinear transformation to a partial differential equation, in which the nonlinear term represents a small perturbation. The general procedure of solution for the resulting weakly nonlinear initial-boundary-value problem is then established by means of the method of successive approximation. Convergence of the analytical solution is also discussed. The solutions to a slab reactor core and a cylindrical reactor core are investigated. Asymptotic stable equilibrium states are derived from each of these solutions. The present results are consistent with those obtained from previous stability analysis for the generalized buckling $K \gtrsim \mu_1^2$, the lowest eigenvalue of the associated linear Helmholtz equation. (auth)

2098 (AEEW-R-915) IMPORTANCE FO FISSION PRODUCT NUCLEAR DATA IN THE PHYSICS DESIGN OF POWER REACTOR CORES. Tyror, J. G. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Dec 1973. 40p. (CONF-731133-4). Dep. NTIS (US Sales Only) $5.00.

From meeting on fission product nuclear data; Bologna, Italy (26 Nov 1973).

The effect of fission product poisoning on the in-core physics performance of fast and thermal reactors is analyzed. The main impact is on fuel reactivity although differential effects associated with temperature and voidage are important as is the effect of Xe-135 on thermal reactor kinetics. The sensitivity of fission product captures to yield and cross-section data is discussed. Target accuracies on fuel reactivity lifetime are set and from these the associated requirements on fission product data are deduced. (24 references) (auth)

2099 (KFK-1890) CONTRIBUTION TO THE MUTUAL RESONANCE SHIELDING OF ^{238}U AND ^{239}Pu. Broeders-Siep, I. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Feb 1974. 28p. (In German). Dep. NTIS (U. S. Sales Only) $4.50.

The material compositions of a typical sodium-cooled fast reactor are used to investigate the influence which the kind of description of the cross section of ^{238}U as a background material has on the effective (n,γ) and fission cross sections of ^{239}Pu, their temperature derivatives, and the Doppler coefficient in the energy range between 10 and 465 eV. On one hand the Narrow Resonance (NR) Approximation is used with an energy-averaged background cross section, σ_0, in which the contribution of ^{238}U is described in three different ways. In a fourth type of calculation the full energy and temperature dependence of the ^{238}U total cross section is taken into account within the NR Approximation. The results are compared and discussed. (7 tables) (auth)

2100 (ORNL-TM-4437) REACTOR CROSS-SECTION SENSITIVITY STUDIES USING TRANSPORT THEORY. Oblow, E. M. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 38p. Dep. NTIS $4.00.

An approach to making reactor sensitivity studies and reactor parameter uncertainty analysis using transport theory is developed. Sensitivity functions based on variational principles are reviewed and compared with an alternate approach using generalized perturbation theory. The computational implementation of the method using transport codes is also discussed. Finally, the use of cross-section error files in conjunction with sensitivity coefficients in estimating uncertainties in reactor parameters is described. 16 references. (auth)

2101 STUDIES IN NUCLEAR REACTOR DYNAMICS. I. The Accuracy of Point Kinetics. II. The Effect of Delayed Neutrons on the Spectrum of the Group-Diffusion Operator. Apostolakis, G. E. Pasadena, CA; California Inst. of Tech. (1973). 76p. University Microfilms Order No. 73-31,033.

Thesis (Ph.D.).

A theoretical study on the space-time dynamic behavior of a nuclear reactor without feedback is described. Diffusion theory with G-energy groups is used. (I) The accuracy of the point kinetics (lumped-parameter description) model is examined. The fundamental approximation of this model is the splitting of the neutron density into a product of a known function of space and an unknown function of time; then the properties of the system can be averaged in space through the use of appropriate weighting functions; as a result a set of ordinary differential equations is obtained for the description of time behavior. It is clear that changes of the shape of the neutron-density distribution due to space-dependent perturbations are neglected. This results in an error in the eigenvalues and it is to this error that bounds are derived. This is done by using the method of weighted residuals to reduce the original eigenvalue problem to that of a real asymmetric matrix. Then Gershgorin-type theorems are used to find discs in the complex plane in which the eigenvalues are contained. The radii of the discs depend on the perturbation in a simple manner. (II) In the second part the effect of delayed neutrons on the eigenvalues of the group-diffusion operator is examined. The delayed neutrons cause a shifting of the prompt-neutron eigenvalues and the appearance of the delayed eigenvalues. Using a simple perturbation method this shifting is calculated and the delayed eigenvalues are predicted with good accuracy. (Diss. Abstr. Int., B)

2102 OPTIMIZATION OF XENON AND SAMARIUM POISONING IN ^{235}U-FUELLED THERMAL REACTORS. Danguy, L.; Bouquegneau, C.; Randour, P. (Faculty Polytechnique, Mons, Belgium). Rev. X; No. 3, 30-34(1972). (In French).

A diagram binding control duration, flux and reserve of reactivity is presented for xenon-135. Samarium poisoning is also considered and separately studied by applying Pontryagin's maximum theorem. The problem of optimizing the total poisoning is set and discussed. (auth)

2103 CONDITIONAL POLARITY CORRELATION METHOD FOR IMPROVED REACTOR NOISE ANALYSIS. Yasuda, H. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 12, 753-761(Dec 1973).

A correlation function for reactor noise is determined through a conditional polarity-correlation technique in which the polarity of neutron-counting fluctuations is analyzed with the start condition that the counting rate reaches a preset level. This is an example of the flash-start technique developed for the purpose of improving the efficacy of reactor noise analysis. In the present case, the conditional polarity-correlation function is described mathematically assuming that the counting fluctuations of the detector conform with a Gaussian distribution. The expression thus derived reveals that this function is approximately proportional to a cross-correlation function and is a differential type of polarity-correlation function. In order to examine the validity of the obtained expression, an experiment was performed in a graphite-moderated reactor at slightly subcritical state to measure the conditional polarity-correlation function. A novel contrivance was adopted in the experiment to eliminate the dead-time effect created during the busy time of the multi-channel time analyzer. The dependence on the preset level—i.e., flash-start condition—exhibited by the conditional polarity-correlation function showed good agreement with that expected from the mathematical expression. The prompt mode neutron decay constants were determined from the experimental data within statistical error of 3 ~ 4%. (auth)

2104 RESPONSE OF REACTOR POWER TO FLUCTUATIONS OF INLET MASS FLOW RATE. Ogawa, Y.; Komatsu, H. (Hokkaido Univ., Sapporo). J. Nucl. Sci. Technol. (Tokyo); 11: No. 1, 29-33(Jan 1974).

2105 ENERGY-DEPENDENT NEUTRON TRANSPORT IN TWO ADJACENT MEDIA. II. Rajamaeski, M. (Univ., Helsinki). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 97, 1-27 (1973).

Particular numerical methods of solving the equations recently obtained for the coefficients of the two-half-range singular-eigenfunction expansion are presented. The most remarkable of these is the acceleration of convergence in iteration of the Fredholm equation associated with the Hilbert problem. Numerical results are given for a Milne problem of two adjacent media. (auth)

2106 RECIPROCITY RELATIONS IN RESPONSE MATRIX THEORY. Lindahl, S. O. (ASEA–ATOM, Vasteras, Sweden). Nucl. Sci. Eng.; 53: No. 4, 475-488(Apr 1974).

Using the multigroup diffusion equation, a reciprocity relation is established for an arbitrarily shaped body. This relation expresses the flux caused by a source inside the body in terms of the flux resulting from an incident current on that body. In the multigroup case for one-dimensional bodies with flat sources and in the one-group case for rectangular two-dimensional bodies with an arbitrary source, practical formulas are derived from this relation. These give the leakage from a body in terms of its reflection and transmission properties. An advantage of the use of this reciprocity relation is the improved computational efficiency in response matrix calculations. (auth)

2107 FINE NEUTRON-SPECTRUM EFFECTS ON SPATIAL CALCULATIONS FOR FAST-REACTOR DESIGN. Corcuera, R.; Khairallah, A. (CEN de Cadarache, Saint-Paul-Les-Durance, France). Nucl. Sci. Eng.; 53: No. 4, 420-435(Apr 1974).

The importance of the structure of the detailed neutron spectrum, and in particular, its spatial dependence, in typical core-blanket and core-reflector fast-reactor configurations is investigated. The validity of current weighting spectra used in few-group (~25) cross-section sets is established as are the limits of variation of coarse-group cross sections. Variations in neutron-capture and fission coarse-group ($\Delta U \cong 0.5$) microscopic cross sections are found to be important only at very low energies and for the threshold reactions such as ^{238}U fission. Important variations are also present in some of the most relevant components of the inelastic-scattering matrix. A systematic compensation of effects in elastic slowing down around the interface is found and analyzed. Some systematic effects may lead to deviations of the order of 0.5% in the value of k_{eff}. Nevertheless, spatial variations of coarse-group cross sections may, in general, be neglected for the prediction of reaction-rate distributions, provided an appropriate though easily calculated weighting spectrum is used for collapsing all the detailed nuclear data in each medium. The only exception occurs in weakly absorbing reflector media where spatial variation of the spectrum is very strong. (auth)

2108 METHOD OF COMPUTING FISSION-PRODUCT DECAY HEAT IN A REACTOR WITH TIME-DEPENDENT FLUX. Barclay, F. W.; Dormuth, K. W. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Nucl. Sci. Eng.; 53: No. 4, 436-439(Apr 1974).

A system of equations is given that can be used to compute the total energy release rate, as a function of time, due to fission-product decay in a uranium-fueled reactor with a time-dependent flux. The use of the equations is demonstrated by simulating a reactor power maneuver with the time variation of fission-product power accounted for, and their time integral is compared with experimental measurements. (auth)

2109 SOLUTION OF NEUTRON-DIFFUSION PROBLEMS IN HETEROGENEOUS FLAT REACTORS BY THE DIRECT VARIATIONAL METHOD. Isaev, N. V.; Slesarev, I. S. Sov. J. At. Energy (Engl. Transl.); 34: No. 3, 244-245(Mar 1973).

Translated from At. Energ. (USSR); 34: No. 3, 194(Mar 1973). This is a summary of paper No. 652/6911 with full copy held by TIC.

A method for solving the neutron diffusion equation for a reactor consisting of arbitrarily positioned multiregion cylindrical modules (control rods, coaxial zones, etc.) is proposed. An example for a two-region reactor is presented. (JWR)

2110 OPTIMIZATION OF REACTOR REACTIVITY BEHAVIOR BY BURNABLE POISONS. Voronkov, A. V.; Chuyanov, V. A. Sov. J. At. Energy (Engl. Transl.); 34: No. 3, 243-244 (Mar 1973).

Translated from At. Energ. (USSR); 34: No. 3, 193(Mar 1973). This is a summary of paper No. 651/6812 with full copy held at TIC.

A method for calculating burnable poison requirements for optimizing reactivity behavior throughout a fuel cycle for given reactor geometry is presented. The mathematical formulation of the problem is described and the use of different types of optimizing functionals is discussed. (JWR)

2111 EFFECT OF RANDOM MATERIAL DENSITY ON REACTOR CRITICALITY. Williams, M. M. R. (London Univ.). Atomkernenergie; 22: No. 4, 248-250(1974).

The effect of a randomly dispersed fuel distribution on the critical flux shape and criticality condition was studied using the one-speed, diffusion equation in a bare reactor. A stochastic integral equation was formulated and a solution for the mean value obtained by means of appropriate closure approximations. Using asymptotic reactor theory, results indicate that the critical buckling of the system is a complex quantity and leads to a fundamental solution which is distorted near the system boundaries due to the effect of randomness. The critical equation indicates that randomness increases the critical size for a given amount of fuel. These results are in qualitative agreement with experiments. Some generalizations of these ideas are discussed in connection with pulsed neutron, diffusion length and neutron wave experiments. (GE)

2112 COMPLEX LATTICE TO A P_3-APPROXIMATION. Galanin, A. D.; Torlin, B. Z. At. Energ. (USSR); 36: No. 2, 125-129(Feb 1974). (In Russian).

On the basis of the general theory of a heterogeneous reactor, equations for designing a complex cell to a P_3-approximation are formulated. The neutron (proper field) of each block is assumed to have axial symmetry. Special attention is devoted to the case of weak absorption in the moderator. The main application of the developed theory is in the determination of the mutual block effect in a complex cell. (5 references) (auth)

2113 PROBLEMS IN NEUTRONICS. Mayer, L. (Kernforschungszentrum, Karlsruhe, Ger.); Werner, W. (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

The need for three-dimensional computer codes is explained, mainly with a view to safety problems, and the boundary conditions associated with the available computers are discussed. Furthermore, the most important features of direct and indirect methods and the resulting main fields of applications are outlined. (GE)

Reactor Components and Accessories

Refer also to abstracts 252 and 833.

2114 (CONF-720468-, pp vp Paper 5) REPORT ON PVRC TASK GROUP ON UNDERCLAD CRACKING. Wylie, R. D. (Southwest Research Inst., San Antonio). 1972.

From 6th annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Several investigations have been made into the mechanism of cracks detected under the cladding on a number of reactor pressure vessels. The Pressure Vessel Research Committee (PVRC) established a Task Group with which various industrial organizations could discuss and compare information generated in their laboratories. A questionnaire has been submitted to a number of knowledgeable firms throughout the free world. This paper describes the background of the problem, the proposed program of the Task Group, and some of the results obtained from the questionnaires received to date. (DLC)

2115 (CONF-720468-, pp vp Paper 12) RESEARCH ACTIVITIES AT THE MPA STUTTGART IN THE FIELD OF NUCLEAR PRESSURE VESSEL TECHNOLOGY: MATERIAL–WELDING–SAFETY. Kussmaul, K.; Sturm, D. (Univ., Stuttgart). 1972.

From 6th annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The empirical safety evaluation of welded thick-walled, large-diameter pressure vessels manufactured from medium strength low-alloy structural steels is a main field of activity at the MPA Stuttgart. Numerous tests and failure analyses throw light on specific safety considerations regarding stress level, toughness, and kind and size of defects as the decisive criteria. In all cases the basic importance of critical areas in the structure such as embrittlement and unfavorable overall stress conditions for fracture initiation was proved. Apart from full-scale tests it seems only possible to simulate the overall conditions in the structure by means of representative large-scale tests. Therefore in the past, besides the tests with small specimens and model vessels, full-scale tests with more than a dozen pressure vessels were performed. The dimensions ranged from 1000 to 1900 mm OD and 20 to 115 mm wall thickness. Eight more vessels with a wall thickness between 90 and 125 mm, two of which were manufactured

with special regard to simulate reactor pressure vessels, are available. In the framework of future BRD research a program was proposed by the MPA covering some unanswered questions. An essential part of these proposals based on small and large specimens and full-scale vessels deals with weldability and welding properties of 22 NiMoCr 37 steel, similar to A508 Cl. 2, especially investigating embrittlement and crack formation during fabrication and service. Preliminary tests concerning stress relief embrittlement and stress relief cracking are under way, as well as crack growth rate studies with extremely low frequencies and at service temperature. (23 figures) (auth)

2116 (CONF-720468-, pp vp Paper 16) ELASTIC-PLASTIC BEHAVIOR OF A LONGITUDINAL SEMIELLIPTIC CRACK IN A THICK PRESSURE VESSEL. Marcal, P. V.; Bettis, R. S. (Brown Univ., Providence). 1972.

From 6th annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The mesh generator developed previously for tensile specimens with semielliptic cracks was modified to generate thick-walled cylinders with longitudinal cracks. A numerical model of the flawed thick cylinder was then analyzed by the three-dimensional finite element program developed in previous HSST projects. Three thousand degrees of freedom were used in the idealization with fixed end conditions. An elastic perfectly plastic material was assumed. Results were then plotted and compared qualitatively with the results for a simple tensile specimen obtained previously. (auth)

2117 (CONF-720468-, pp vp Paper 17) SHAPE FACTORS FOR NOZZLE CORNER CRACKS OBTAINED FROM EPOXY MODEL PRESSURE VESSELS. Derby, R. W. (Oak Ridge National Lab., TN). 1972.

From 6th annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

Epoxy model pressure vessels were fabricated and fatigue cracks were grown in the nozzle regions. The vessels were burst and the remains of each vessel cut into K_{Ic} specimens and tested. By assuming that K_I around the nozzle corners cracks was equal to K_{Ic}, it was possible to calculate the shape factor C from the fundamental equation of fracture mechanics: $K_I = C\sigma_n\sqrt{\pi a}$, where σ_n is the nominal stress and a is crack depth. (12 figures) (auth)

2118 (CONF-720468-, pp vp Paper 19) PANEL DISCUSSION: FIRST INTERMEDIATE PRESSURE VESSEL TEST. Derby, R. W.; Robinson, G. C.; Witt, F. J. (Oak Ridge National Lab., TN). 1972.

From 6th annual information meeting on heavy section steel technology program; Oak Ridge, Tennessee, USA (25 Apr 1972).

In sixth annual information meeting on heavy section steel technology program.

The first of the series of 6-in.-thick pressure vessels is fabricated from ASTM A508 class 2 forging steel. The cylindrical test course is a seamless forging some 54 in. long. A prolongation of the course 24 in. long was removed prior to welding on the heads. The strength and fracture properties of the prolongation, which are hopefully typical of the test course, are being extensively investigated. Tensile and Charpy impact behavior are defined. Quantitative fracture toughness values are determined from precracked Charpy specimens, and 0.85-in.-thick and 4-in.-thick compact tension specimens. In addition, flawed model pressure vessels 0.85 in. thick are being tested. From these tests a test temperature for the vessel will be selected at which a prescribed fracture behavior will occur. The available data obtained as a basis for temperature selection is summarized. In addition a presentation is made of the salient design features and the methods used to implement design, procurement, fabrication, and installation of the intermediate test vessel facility. Finally, the instrumentation and preparation of the vessel for testing is summarized. [Preliminary results from the first vessel tests may be presented (orally only) if a vessel is tested prior to the information meeting.] (auth)

2119 (INIS-mf-1021) STATISTICAL METHODS FOR NEUTRON FLUX MEASUREMENT IN NUCLEAR REACTORS. do Rego Feitosa, C. H. (Instituto de Engenharia Nuclear, Rio de Janeiro (Brazil)). Jan 1973. 48p. (In Portuguese). INIS.

The conventional methods for neutron flux measurement in nuclear reactors are introduced and basic shortcomings are analyzed. New methods that overcome these shortcomings are introduced based on the random nature of the phenomenon. Theorems supported by statistical theory are developed, allowing a Statistical System definition that fulfils the required conditions. This system is known as the Campbell System. A functional block diagram for a Campbell System is presented. (INIS)

2120 (RDT-M-16-3-T(3-74)) HEPA FILTER MEDIUM, GLASS FIBER (MIL-F-51079 WITH MODIFICATIONS AND ADDITIONAL REQUIREMENTS). (USAEC Division of Reactor Research and Development, Washington, D.C.). Mar 1974. 13p.

Specifications are given for the medium for use in HEPA filters for nuclear applications, clean rooms, clean-air devices, and other clean-air applications. Standards are given for smoke penetration, tensile properties, water repellency, folding characteristics, thickness, combustion content, packing properties, mildew resistance, and radiation effects. (MCW)

2121 PRESSURE VESSEL TECHNOLOGY. Part 1. Design and Analysis. Proceedings of the Second International Conference, San Antonio, Texas, October 1-4, 1973. New York; American Society of Mechanical Engineers (1973). 612p. $40.00.

Topics discussed include the design and safety of reactor pressure vessels, elastic stresses in pressure vessels, plastic deformation and creep behavior in pressure vessels, pressure vessel piping systems, prestressed concrete vessels, special vessels and components, acoustic emission testing of pressure vessels, fatigue strength and fracture mechanics of pressure vessels, the fabrication of pressure vessels and piping, and materials used in such fabrication. (IAA)

2122 NUCLEAR CONTAINMENT VESSEL AND METHOD OF MAKING SAME. Jordan, R. W.; Cornith, R. L.; Edwards, N. W.; Preg, S. M. Jr. (to Pittsburgh-Des Moines Steel Co.). US Patent 3,793,145. 19 Feb 1974. Filed date 25 May 1971. 20p.

A nuclear containment vessel and a method of fabrication are described. The vessel comprises a closed shell of revolution having a substantially doubly curved shape with an elongate vertical dimension. The shell comprises a plurality of different portions merging into one another, at least one of the portions having different curvature or different thickness, or different curvature and thickness than adjacent portions. (Official Gazette)

2123 PRESSURE TEST OF A ONE-TENTH SCALE MODEL OF PRESTRESSED-CONCRETE REACTOR PRESSURE VESSEL. Kuroda, T. (Electric Power Development Co. Ltd., Tokyo); Murakami, H.; Hisatomi, Y.; Isohata, O. Semento Konkurito; No. 315, 2-11 (May 1973). (In Japanese).

A series of tests on the performance of a one tenth scale model of PCPV was performed and analyzed jointly by the Electric Power Development Co. and the Simizu Construction Co. The tests consisted of two phases. The first was "design-pressure test" in which elastic performance of the PCPV was investigated. The second was "ultimate pressure test" in which inner pressure was raised until destruction. The design-pressure was 43 kg/cm^2. Outline of the one tenth scale model, namely components and characteristics of concrete, arrangement of tendons and instruments, the tensile force applied on the tendons, etc., is given. The experimental method is described. The results of experiment were compared with those obtained by two independent finite element codes. (JA)

2124 IMPROVEMENTS IN THE MANUFACTURE AND MOUNTING OF NUCLEAR REACTOR SKIRTINGS. (to Societe Babcock-Atlantique). French Patent 2,123,278. 30 Apr 1971. 9p. (In French).

A nuclear installation is considered. The reactor core, formed of vertically elongated elements tightly confined by a holder, is contained in a vertical vessel. A cylindrical skirting separates the core from the vessel. A procedure, which facilitates the construction of these skirtings, is presented together with their installation. This procedure, which reduces the costs involved, consists of associating the skirting with a spacing system (screw jacks) capable of maintaining the skirting in a rigid but regulatable manner by pressure against a rigid element of the installation. The spacing systems proposed can be positioned at several levels without difficulty. In this way the skirting is protected against vibration risks, the bulk being reduced. The procedure leads to a light and flexible reactor skirting acting essentially as a guide for the coolant and protected against vibrations by the spacing system which maintains it rigid by pressure against the vessel and the fixed holder of the core. (FR)

2125 CELL EQUIPMENT FOR THE MANIPULATION OF NUCLEAR REACTOR ELEMENTS. Napgueron, J. (to Societe Creusot-Loire). French Patent 2,154,277. 26 Aug 1971. 7p. (In French).

Equipment for manipulating vertical axis nuclear reactor core fuel assemblies is presented. It consists of a suspension plug which is coaxial with the core and provided with instruments for the control of these assemblies. This plug is eccentrically mounted in another plug which eccentrically supports a manipulating arm.

The assemblies are gripped by a part positioned at the end of this arm. The special features of the equipment are that it is provided with a movable chamber which can be mounted into the second plug in a leaktight manner outside the reactor, the chamber being designed to house a substantial part of the first plug separated from the second plug. (FR)

2126 EXPANSION TANK FOR COOLING CIRCUITS WITH CIRCULATING PUMPS. Steinmueller, H. F.; Profe, H.; Lehmann, G. (to Licentia Patent-Verwaltungs GmbH). German(FRG) Patent 1,551,473. 1 Mar 1973. 3p. (In German).

The expansion tank described is used in a circuit to cool structural elements that are not on electric earth potential. In this circuit, the cooling water is in direct contact with the potential of the structural elements. To avoid corrosion, the electric conductivity of the water must be kept low. Consequently, apart from fulfilling its primary functions, the expansion tank is used to equalize changes in the level of the water produced by temperature variations or other causes, and also to extract the oxygen or other gases contained in the cooling water which raise its conductivity. The patent deals with the constructional solution of these problems. (GE)

2127 THERMAL INSULATION OF PRESTRESSED CONCRETE PRESSURE VESSELS OF NUCLEAR REACTORS. Nitsche, H.; Pfaender, E. (to Siemens AG). German(FRG) Patent 1,614,584. 12 Apr 1973. 3p. (In German).

The thermal insulation between the concrete wall and the inner lining of the pressure vessel consists of multiple layers with cavities filled with a gaseous or liquid medium. The cavities are formed by form-locking layers of foils showing stampings. (GE)

2128 IMPROVEMENTS IN AND RELATING TO TURBINES. (to Reyrolle Parsons Ltd.). British Patent 1,338,259. 21 Nov 1973. Filed date 15 Jun 1970. 5p.

Reference is made to vapor turbines designed to operate under conditions in which both vapor and liquid are present in the turbine. The improved system described comprises a turbine of the multi-flow type that has at least two main flow paths for fluid through the turbine, and a number of bladed rotor stages. Means are provided for extracting liquid entrained in the vapor passing through the first main vapor flow path, positioned so as to extract the liquid at a stage of the vapor expansion within the turbine upstream of a final bladed rotor stage at the low pressure end of the turbine, and to extract a portion of the vapor, together with the liquid. The arrangement further provides for return of the vapor to the second main vapor flow path of the turbine, subsequent to expansion of vapor and liquid, at a stage of the vapor expansion where pressure of the vapor is only slightly lower than the pressure at which it was extracted from the first main vapor flow path, the vapor being returned up-stream of at least one bladed rotor stage. (UK)

2129 NUCLEAR REACTORS. Banks, R. (to Nuclear Power Group Ltd.). British Patent 1,338,898. 28 Nov 1973. Filed date 14 Jan 1970. 5p.

In reactors operating in areas where they may be subject to seismic shock it is necessary to clamp movable components to fixed members. This is particularly the case with fuel charging machines. The machine described comprises a pair of cross members forming a gantry that can move along two fixed guide rails at right angles to the cross members, and a fuel charging flask that can move along the cross members. Wedging devices are located between the gantry and the guide rails and between the flask and the cross members, these devices consisting of wedges positioned on either side of an actuating member, movement of which causes the wedges to move apart to clamp associated surfaces of the gantry and guide rails and of the cross members and charging flasks. A seismic shock detector may be provided to operate the wedging devices if the charging machine moves under the influence of a seismic shock. (UK)

2130 POWER TRANSMISSION SYSTEM FOR CONNECTING FLOATING POWER PLANT TO STATIONARY CONDUCTORS. Perry, E. R.; Samm, R. W. (to I-E-T Imperial Corp.). US Patent 3,794,849. 26 Feb 1974. Filed date 18 Aug 1972. 8p.

A nuclear power plant is mounted on a floating barge stationarily moored within a sea wall, with the barge rising and falling with the tide. Underwater conductors fixed relative to the sea bed and extending from the shore to the barge are connected to the floating power plant by a freely suspended, horizontal transmission line section, which extends beneath the barge and is always completely submerged. This transmission line section is weighted to have neutral buoyancy, whereby the transmission line section flexes as a catenary as the barge rises and falls with the tide. (Official Gazette)

2131 PRESSURE VESSELS. Davies, I. L.; Burrow, R. E. D. (to Taylor Woodrow Construction Ltd.). US Patent 3,794,559. 26 Feb 1974. Priority date 29 Jul 1970, United Kingdom of Great Britain and Northern Ireland. 6p.

A concrete pressure vessel is described having a lined cavity for hot, chemically aggressive liquid disposed within a cooling jacket with a layer of material of high thermal conductivity between the cavity liner and the cooling jacket. The jacket and high thermally conductive layer serve to maintain the temperature of the cavity liner within closely controlled limits and the maximum temperature of the main body of the vessel at an acceptable level. The jacket and the conductive layer also serve to prevent leakage of liquid from the cavity. (Official Gazette)

2132 PRESSURE VESSEL TECHNOLOGY. Part 2. Materials, Fabrication, and Inspection. Proceedings of the Second International Conference, San Antonio, Texas, October 1–4, 1973. New York; American Society of Mechanical Engineers (1973). 572p. $40.00.

2133 IODINE SORPTION PLANTS FOR NUCLEAR POWER STATIONS. Staschik, G.; Strauss, H. J.; Winter, K. (CEAG Dominit AG, Dortmund, Ger.). (1973). vp. (In German).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Trapping radioactive iodine or organic iodine compounds by activated charcoal is temperature dependent, it is advantageous to put inorganic adsorbents into the containment filters, which have been specially fitted. These adsorbents can be placed either in flat or circular layers, the latter being more efficacious in meeting the requirements. In this case adsorption can be maintained up to a temperature of 300°C, if the sorbents on a ceramic base are specially impregnated. (GE)

2134 IODINE TRAP TESTING IN NUCLEAR POWER STATIONS. Sigli, P.; Trehen, L. (CEN, Fontenay-aux-Roses, France). (1973). vp. (In French).

From seminar on iodine filter testing; Karlsruhe, Ger. (4 Dec 1973).

Details of the technique used for testing iodine traps are presented. Labelled ^{131}I and methyl iodide can be injected upstream of the trap in the piping system where the pressure is less than 1.4 bar. Samples on standard elements are taken upstream and downstream of the activated charcoal trap. The efficiency is evaluated by measuring the trapped activities. The sampling method allows comparison of the overall efficiency of the trap with that of a bed of the same kind and the same thickness operating under the same conditions (relative humidity, temperature) as the trap itself. (GE)

2135 PRESERVICE AND IN-SERVICE TESTING OF NUCLEAR REACTOR COOLANT SYSTEMS. Turbak, M. S. (Commonwealth Edison Co., Morris, IL). Proc. Amer. Power Conf.; 35: 325-327(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The work necessary before the in-service inspection commences include considerations of radiation dose rates, previous test data, critical path, locating of equipment with diagrams and pictures, and keeping records of the examinations. Consideration of other work being performed during the testing must be planned. In-service inspection requirements are found for each specific reactor in its technical specifications. (MCW)

2136 PREOPERATIONAL WATER CHEMISTRY CONTROL FOR NUCLEAR STEAM SUPPLY SYSTEMS. Beach, R. R. (Babcock and Wilcox, Lynchburg, VA); Bell, M. J.; Hicks, J. H.; Pocock, F. J. Proc. Amer. Power Conf.; 35: 892-901(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The continuous water chemistry development program maintained by Babcock and Wilcox to provide control techniques and guide specifications that establish the needed laboratory support, equipment, personnel, and water quality requirements for NSS systems is described. Water quality control prior to and during flushing, initial fill, and preoperational testing is described along with secondary system steam and condensate system flushing, chemical cleaning, and water conditioning such that steam generator inlet water quality specifications are met during hot functional testing. (MCW)

2137 AEROELASTIC BEHAVIOR OF AN ISOLATED CYLINDER POSITIONED NORMAL TO THE FLOW. Loisesu, H.; Szechenyi, E. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). pp 133-158 of Recherches Actuelles et Applications Industrielles. Paris; Eyrolles (1973). (In French).

From fluid mechanics summer school; Ermenonville, France (4 Sep 1972).

In both thermal and nuclear plants, numerous cases of flow around profileless objects (in particular objects of circular

cross section) occur. The vibrations induced can pose great difficulties for inaccessible and irreparable parts as well as for whole structures (large chimneys), and can produce intolerable noises. Studies carried out on nonstationary lifts experienced by isolated cylinders with axes perpendicular to the wind established the existence of different flow regimes. The sub-critical domain begins at a Reynolds' number of 6.5×10^5 for a smooth cylinder. When the cylinder is rough it is possible to enter significantly into this domain and still have harmonic lifts which are considerably below the former value. The supercritical limit appears to be related to the Reynolds' number for the roughness and not to the diameter of the cylinder. The effect of the amplitude of vibration on the lift spectra and span correlation was studied. The instability regions were well defined. The analysis performed enabled a mathematical formulation to be established for predicting the nonstationary lifts experienced on deformable mock-ups. (FR)

2138 RADIAL PREFILTERS OF HIGH UNIT CAPACITY FOR CONDENSATE CLEANUP IN HIGH-CAPACITY POWER GENERATING UNITS. Prokhorov, F. G.; Khodyrev, B. N.; Pis'man, B. Ya.; Lomachenko, G. N.; Fedoseev, B. S.; Kostin, V. D.; Tishchenko, G. D. Therm. Eng. (USSR) (Engl. Transl.); 20: No. 5, 1-8(May 1973).

Translated from Teploenergetika; 20: No. 5, 2-7(May 1973).

A high-capacity condensate cleanup prefitter for use in large power stations is described. The condensate entering this filter is supplied to the bed in a radial direction. The performance of the filter is discussed. (JWR)

2139 STRESS-CORROSION IN THE POWER INDUSTRY. Board, J. A. (British Nuclear Design and Construction Ltd., Whestone, Eng.). J. Inst. Metals; 101: 241-247(Sep 1973).

From spring meeting on stress-corrosion in practice; London, Eng. (22 Mar 1973).

The experience of stress-corrosion cracking in operational power plants is reviewed and the methods being adopted to avoid stress-corrosion cracking in future nuclear boilers are discussed. Stress-corrosion cracking has been reported in turbine discs in ferritic steel, mild-steel boiler tubing, austenitic stainless-steel superheater tubing, Type-304 stainless steel in BWR, and Inconel 600 steam-generator tubing in PWR. Cracking can be avoided by changes in detail design such as the avoidance of crevices and highly stressed regions or by closer control of contaminants in boiler-feed water. Alloys resistant to stress-corrosion cracking such as 12% Cr steel and alloy 800 are finding increasing application in power plants. (auth)

2140 ACOUSTIC METHOD OF MEASURING SMALL DEFORMATIONS AT HIGH TEMPERATURES IN RADIATION FIELDS. Zelenchuk, A. V.; Naboichenko, K. V. At. Energ. (USSR); 36: No. 2, 130-132(Feb 1974). (In Russian).

An acoustic impedance method of measuring small deformations in reactor channels is considered. The principle and theory of the method of measurement are given. Experimental and theoretical characteristic curves of a helium-filled acoustical transducer for temperatures up to 500°C, using temperature-amplitude compensation, are presented. Recommendations for calculating desired measurement ranges of small deformations are made. According to the theory, such transducers can operate at high temperatures, intense radiation fluxes, and be several meters long and have small radial (several millimeters) dimensions, which is of particular interest since reactor channels have small radial dimensions. (6 references) (auth)

2141 RADIATION DAMAGE UNITS FOR FAST REACTOR STEELS. Bramman, J. I. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Etherington, E. W.; Nelson, R. S.; Norgett, M. J. pp 27-31 of Irradiation Embrittlement and Creep in Fuel Cladding and Core Components. London; British Nuclear Energy Society (1973).

From conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Radiation damage models which have been developed within the UKAEA are reviewed. The most recent model, resulting from collaboration between Saclay, Oak Ridge and Harwell (Norgett, Robinson and Torrens, AERE Harwell Report TP494, Oak Ridge National Laboratory Report SSD 72-70 and Centre d'Etudes Nucleaire de Saclay Report CEA-R4389), is now recommended by the IAEA as an international standard of damage dose. (auth)

Reactor Fuels

Refer also to abstracts 60, 188, 221, 222, 224, 283, 328, 766, 774, and 787.

2142 (AAEC/E-273) FLOW OF SPHERES AND NEAR SPHERES IN CYLINDRICAL VESSELS. Part IV. Individual Flow Paths in Recirculated Random Packings. Gatt, F. C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1973. 154p. Dep. NTIS (U. S. Sales Only) $10.75.

An experimental investigation was made of the transit of individual pebbles in recirculated random packings of equal spherical or aspherical pebbles. Pebbles of 1.0 inch or 0.75 inch nominal diameter and 3.0 or 3.4 specific gravity are used to form beds in a 30 inch diameter vessel with a concave base and single axial outlet. The pebbles flow downwards under the influence of gravity through a rotating extractor in the base. A radioactivity tagged pebble is inserted at the top of the bed and as it descends with the pebble packing its position is detected and recorded at intervals using a tracking device. In this way tracks and velocities of pebbles seeded in the bed for various combinations of seeding radius, bed and pebble parameters are determined, and are found to be generally of "streamline" form. The extractor rotation has very little effect on the motion of the pebbles in the bed. Using the tracks of tagged pebbles, patterns and effects of flow zones are deduced. 20 references. (auth)

2143 (KFK-1916) TEMPERATURE DISTRIBUTION IN A NUCLEAR FUEL PIN, STRESSED BY DIFFERENT SORTS OF HEAT SOURCES. Keller, K. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Jan 1974. 38p. (In German). Dep. NTIS (U. S. Sales Only) $5.00.

From the general heat conduction equation, solutions are developed that describe various possible operational conditions of nuclear fuel pin. These solutions are analytically transformed to a state permitting ready and organizationally lucid digital programming. (GE)

2144 (STI/PUB-303) BEHAVIOR AND CHEMICAL STATE OF IRRADIATED CERAMIC FUELS. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, Austria, August 7-11, 1972. (International Atomic Energy Agency, Vienna (Austria)). Jan 1974. 443p. (In French and English). (CONF-720843-). IAEA $20.00.

Thirty papers are included on transport properties, fuel/fission product-clad interaction, and thermodynamics and phase equilibria of fuel materials. Emphasis is on mixed oxide fuels for sodium-cooled fast reactors. The panel's summary and recommendations are also included. Separate abstracts were prepared for all 30 papers. (DLC)

For abstracts of individual papers see: 769, 786-809, 950, 1952, 2085, 2086, and 2150.

2145 SYSTEM FOR AXIALLY BLOCKING NUCLEAR REACTOR FUEL ASSEMBLIES. (to Electricite de France). French Patent 2,166,312. 7 Jan 1972. 8p. (In French).

A device is presented for the axial blocking of nuclear reactor fuel assemblies (chiefly for fast neutron reactors). The core of the reactor is formed from a vertical group arrangement of the assemblies and is connected to the reactor bed at its lower end, and to the reactor lid at its upper end. The bed of the reactor has a grid-like structure, the ends of the assemblies being fitted into the gaps of this structure. The reactor lid is in the form of a movable block provided with special devices which control the functioning of the assemblies during reactor operation. The underneath of the lid is provided with hollow conically shaped housings into which the fuel assemblies fit under the action of pressure from the coolant fluid; this fluid traverses the assemblies from the bottom to the top; it is fed into each assembly through an opening at its lower end which is in line with the axis of the foot of the assembly. The distance between the bearings and hollow housings and the bed of the reactor slightly exceeds the length of the assembly which may thus expand as a result of thermal or neutron effects. (FR)

2146 LIQUID-COOLED NUCLEAR REACTOR FUEL ELEMENT. zu Baringdorf, G. (to INTERATOM). German(FRG) Patent 1,564,132. 23 Aug 1973. 5p. (In German).

The purpose of the invention is to ensure complete equalization of the buoyant force of the coolant flow even in the case of a drop in pressure, so that the full weight of fuel element acts upon the lower tie plate. This is achieved by a compensating chamber mounted inside the fuel element casing above the lower tie plate. The chamber is arranged in the control axis of the fuel element, with the coolant flow passing the pressureless compensation chamber at all sides. A complete compensation of the buoyant force can be achieved by a corresponding dimensioning of the chamber. The layout and arrangement of the chamber at the bottom fitting of the fuel element are described. (GE)

2147 FUEL SPHERE PILE REACTOR. Rohr, F. US Patent 3,794,560. 26 Feb 1974. Priority date 26 Nov 1970, F.R. Germany. 4p.

Fuel sphere pile reactor is described including a pile of nuclear

fuel elements each formed of a spherical first container wherein nuclear fuel is received. Each of the fuel elements is received in a second container having at least an outer spherical shape and having an inner volume greater than the volume of the first container. The second container is formed with perforations for admitting coolant to the interior of the second container to be received therein in addition to the first container. (Official Gazette)

2148 METHOD OF MANUFACTURING A NUCLEAR FUEL ASSEMBLY SPACER. Ripley, C. C. (to General Electric Co.). US Patent 3,789,476. 5 Feb 1974. Filed date 15 Mar 1971. 10p.

A method for manufacturing an expanded sheet spacer for nuclear fuel rod assemblies is presented. In general the method has the first step of forming a plurality of spaced slits along parallel lines on a sheet material so that each slit has a length of at least two times the distance between pairs of slits and the center of each slit is located adjacent the space between slits of the next line of slits. The second step of the method is bending the sheet below each slit perpendicular to the slits so that a portion of the sheet below each slit is displaced in the same direction away from the original plane of said sheet and a plurality of channels having axes substantially parallel to each other and to the plane of the sheet are formed. (Official Gazett)

2149 METHOD OF INSERTING FUEL RODS INTO INDIVIDUAL CELLS IN A FUEL ELEMENT GRID. Jabsen, F. S. (to Babcock and Wilcox Co.). US Patent 3,795,040. 5 Mar 1974. Filed date 28 Oct 1971. 10p.

A fuel element assembly technique is described that facilitates the insertion of a fuel rod into a cell which is formed by a resilient grid structure. Initially, a cam is introduced into the cell. The inserted cam is rotated to deflect the grid surfaces that comprise the cell walls. This deflection prevents a leaf-spring mounted detent formed in the grid surface from extending into the path of the fuel rod. A key with a dimension that generally matches the deflected grid is inserted into the cell in order to engage the temporarily bowed grid surface. The inserted cam is rotated back to the initial orientation relative to the cell configuration and is withdrawn from the grid structure. The deflecting key lodged against the bowed grid surface, however, sustains the deflection in order to enable the fuel rod to be inserted into the cell without being abraded by the detent. After fuel rod insertion, the matching dimension portion of the deflecting key is disengaged from the grid surface and the key is withdrawn from the cell to release the leaf spring and allow the detent to clutch the fuel rod. (Official Gazette)

2150 DETERMINATION OF BURN-UP AND HEAVY ISOTOPE AND FISSION PRODUCT CONTENTS OF THERMAL AND FAST REACTOR FUELS. Vidal, R.; Robin, M.; Devillers, C. (CEA, Fontenay-aux-Roses, France). pp 67-75 of Behavior and Chemical State of Irradiated Ceramic Fuels. Vienna; International Atomic Energy Agency (1974). (In French).

From panel on the behavior and chemical state of irradiated ceramic fuels; Vienna, Austria (7 Aug 1972).

Burnup is frequently the parameter which serves as a reference for purposes of analyzing the numerous phenomena which, from a technological point of view, govern the behavior of fuel elements under irradiation. It is therefore essential to have at one's disposal theoretical and experimental methods capable of determining, with adequate precision, the burnup, the content of heavy isotopes, the percentage of fissions in each of the latter, and the fission-product content, irrespective of whether the sample to be studied is taken from a fuel assembly irradiated in a power reactor or from elements located in irradiation loops in a research reactor. (auth)

2151 QUALITY ASSURANCE IN THE NUCLEAR FUEL CYCLE. Smiley, S. H. (Atomic Energy Commission, Washington, DC). Nucl. Mater. Manage.; 2: No. 4, 8-12(Win 1974).

The two main aspects of quality assurance in the nuclear fuel cycle are discussed. One relates to the design, construction, and operation of the fabrication, reprocessing, and related plants. The other relates to the design and fabrication of the fuel and its performance in reactors. The implementation of quality assurance programs at all fuel cycle stages is examined. (JWR)

2152 SURVEY OF NUCLEAR FUEL PERFORMANCE EXPERIENCE. Walke, G. J.; Noble, D. M. (Consumers Power Co., Jackson, MD). Proc. Amer. Power Conf.; 35: 209-214(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). CONF-730582-.

The rise since 1960 in the electrical generation from nuclear zircaloy fuel is shown. In 1960, it was about 0.6 billion kilowatt-hours. In 1972, it approached 200 billion kilowatt-hours coming from 29 operating plants. Some operating data with uranium and plutonium fuels are shown graphically. A study of nuclear fuel operating statistics shows that commercial nuclear fuel rods to date have operated with a cumulative reliability of 0.998 to 0.999. The fuel failures are classified into the failure mechanisms: internal contamination, manufacturing defects, abrasive wear, crud-assisted accelerated corrosion, fuel-clad interaction, fuel rod growth, and clad collapse. The research dealing with each failure mechanism is discussed. (MCW)

2153 CORRECTIONS FOR BURNUP DETERMINATIONS TAKING INTO ACCOUNT THE BRED FISSIONABLE SPECIES. Hiller, S. (Siemens AG, Erlangen, Ger.). Kerntechnik; 15: No. 11, 503-507(Nov 1973). (In German).

In burnup determinations of fuels subjected to low burnups, good agreement has always been found between determinations based on the long-lived fission nuclides ^{137}Cs, ^{90}Sr, and ^{144}Ce. By contrast, in the investigation of highly irradiated fuel assemblies from the KWO reactor, there were discrepancies of up to 25%. It was shown by calculations that these discrepancies are definitely due to the increasing contributions of ^{239}Pu and ^{241}Pu to the total power output. With increasing burnup the burnup determinations are increasingly vitiated by differences in the fission yields of different fissionable species. Correction factors, calculated for a wide range of burnups, which make it possible correctly to determine the burnup without having to know the individual contributions of ^{239}Pu, ^{238}U and ^{241}Pu are presented. These factors take into account the differences in the specific energy yields. The calculations show that, as a rule, sufficient accuracy can be achieved by pooling ^{241}Pu with ^{239}Pu and ^{238}U with ^{235}U, and considering only the fission of ^{239}Pu and ^{235}U. This opens the possibility of determining experimentally in a simple manner, from the recorded gamma spectra, sufficiently accurate correction factors for fuels with an unknown enrichment and unknown irradiation history. (GE)

2154 APPLICATION OF ELECTRON BEAM WELDING TO NUCLEAR FUEL MANUFACTURE. Collomb, J.; Moneyron, G.; Savornin, B. (Compagnie pour l'Etude et la Realisation de Combustibles Atomiques, Paris). Soudage Tech. Connexes; 27: No. 11, 489-498(Nov 1973). (In French).

The in-pile behavior of fuel elements and their constructional requirements impose particularly stringent constraints on the welding techniques adopted. Electron beam welding is particularly useful for this purpose. Two important industrial applications of electron beam welding are discussed: electron beam welding of the plugs of the annular elements of the BUGEY 1 power plant onto the magnesium-zirconium cladding and electron beam welding of the fuel plates of the elements of the high flux Franco-German reactor at Grenoble. The problems related to the fuel elements are described for both of these applications. The essential steps followed are discussed and conclusions presented on the welding studies undertaken; the industrial solutions retained are indicated together with the results obtained in industrial manufacturing processes. (FR)

2155 NUCLEAR REACTOR FUEL ROD. Jung, W.; Kaden, W.; Rau, P. (to Siemens AG). German (FRG) Patent 2,203,518. 2 Aug 1973. 7p. (In German).

The fuel rod consisting of cladding and nuclear fuel has an end cap which has been bored through which is metallurgically bound to a special vessel containing a gas absorbing filtering substance to hold back and retard the removal of fission products. The vessel is closed at least at the fission product entering side by a porous or a fission product diffusing body which is gas-tight connected to the container material. The filtering material is pressed into the container. (GE)

2156 COATED FUEL PARTICLES AND METHOD OF FABRICATION. Huschka, H.; Schmutz, H.; Vygen, P. (to Nuklear-Chemie und -Metallurgie GmbH). German (FRG) Patent 2,036,545. 15 Feb 1973. 5p. (In German).

A description of fuel particles coated with pyrolytic carbon only or combined with silicon carbide is given, where the layers of pyrolytic carbon in a radial direction show no one-directional or alternating gradients of optical anisotropy and of other properties. The patent deals with the technical measures in keeping the growth rate constant. (GE)

2157 NUCLEAR REACTOR FUEL ELEMENT AND PROCESS FOR ITS FABRICATION. Spalthoff, W.; Wilhelm, H. (to Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH). German (FRG) Patent 1,639,249. 19 Apr 1973. 4p. (In German).

The nuclear fuel of the fuel element described is formed by an outer shell made of a zirconium base alloy. A hydrogen bonding material is firmly bound to the inner side of the outer shell, at the end cap of the shell tube or also arranged between fuel pellets. The material is galvanically or chemically applied to or sprayed on to the inner side of the outer shell or end cap by means of fusion welding or diffusion welding. The material is

made up of yttrium, cerium or another rare earth metal or from an alloy based on these substances. (GE)

2158 FUEL SUBASSEMBLY FOR NUCLEAR REACTOR. Noyes, R. C. (to United States Atomic Energy Commission). US Patent 3,798,124. 19 Mar 1974. Filed Date 27 May 1969. 4p.

A circular cylinder nuclear fuel subassembly is described which has extended circumferentially spaced containers of moderating material along the outer periphery to permit a plurality of subassemblies to be assembled in contact with each other and the containers occupying the spaces between the subassemblies. (Official Gazette)

Reactor Control Systems

2159 (HEDL-SA-572) VENTED ELEMENTS. Christensen, J. A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 30 Apr 1973. Contract AT(45-1)-2170. 6p. (CONF-730652-1). Dep. NTIS $4.00.

From meeting of the international working group for fast reactors; Dimitrovgard, USSR (4 Jun 1973).

The design and performance characteristics of vented B_4C control elements for the FFTF reactor are presented. (DCC)

2160 (TID-24818, pp 115-125) DESIGN OF A CONTROL SYSTEM FOR A FAST REACTOR-THERMIONIC GENERATOR SYSTEM. Vogel, E. (Fairchild Hiller Corp., Farmingdale, NY). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

Analysis of a fast reactor thermionic generator system establishes the fact that such a system is ordinarily quite stable, but with inordinately large time constants. Thus, an active controller is required to keep temperature excursions within reasonable limits when the plant is disturbed by load changes or by reactivity disturbances. A two loop controller was designed consisting of a tight power demand controller as well as a voltage control loop operating at lower loop gain. The design procedure employed a simple plant description and classical procedures; the design was checked by means of elaborate system simulation and found to be in good agreement with theory. System optimization results are shown both for linear resistive loads and for quasi-constant current loads. (auth)

2161 (TID-24818, pp 126-136) DYNAMIC CHARACTERISTICS AND CONTROL OF A NUCLEAR THERMIONIC POWER PLANT. Wilkins, D. R.; Hill, P. R.; Peck, C. B. (General Electric Co., Pleasanton, CA). Apr 1969.

From thermionic conversion specialist conference; Natick, Massachusetts, USA (23 Oct 1968).

The several components of a nuclear thermionic power plant are discussed from a dynamics point of view. A digital computer program developed to permit linear stability and transfer function analyses and nonlinear transient simulations of both the open and closed loop plants is described. Stability criteria for the open loop plant are derived and it is shown that the open loop plant is stable by a substantial margin. Open loop transfer function and transient results show that the plant responds slowly to reasonable variations in the open loop driving forces. Due to weak reactivity feedback mechanisms, however, the open loop plant exhibits a high gain response to independent variations in either reactivity or reactor electrical current. Possibilities for enhancing the built-in reactivity feedback mechanisms are of positive value but inadequate to render the plant self-regulating. The role of the reactor power conditioning equipment in plant electrical control is discussed. A control system design which permits simultaneous regulation of plant output voltage and TFE emitter temperatures in a reactor consisting of a large number of nonidentical TFEs, some of which may be degraded or failed, is described. Closed loop transient results illustrating the performance of the control system are presented. (auth)

2162 PROBABILISTIC APPROACH FOR DETERMINING NUCLEAR REACTOR CONTROL SYSTEM RELIABILITIES AND RELATED ACCIDENT FREQUENCIES. Godbout, P. J. Los Angeles; Univ. of California (1973). 200p. University Microfilms Order No. 74-1564.

Thesis (Ph.D.).

A procedure to determine nuclear reactor control system reliabilities and related accident frequencies is presented in the context of reliability engineering. Minimal probabilistic or statistical assumptions were made and those based on plausible physical considerations were used, so that the resulting deductions could be safely made about a wide variety of commonly occurring, but control system induced, reliability and safety related situations. The solution of the probability problem is carried out in five steps: (a) the determination of early and current reactor control design philosophies by either the U. S. Atomic Energy Commission or the reactor vendors, (b) the determination of failure rates either through publications, special reports or operating experiences, (c) the introduction of an analysis methodology based on probability theory, reliability theory and fault-tree modeling, (d) the introduction of a special reliability computer code package EKKFA for solving qualitatively and quantitatively, in open form, complex fault-trees of nuclear reactor systems, and (e) the application of steps (c) & (d) to the determination of two nuclear reactor systems (residual heat removal and feedwater) reliabilities and betterment changes: these study cases were chosen as good gauges for assessing the performance of control systems when designed according to the current control system design philosophies. It was calculated, from data search from operating experiences for U. S. nuclear power reactors, that the failure rate of today's control systems was $2.1-10^{-6}$ per item per year at the 80% confidence level. It was assumed that the control system controlled an average of ten safety and operational systems and that each individual system was made of an average of ten major components. Further search of the open literature revealed that most authors of past reliability studies involving control system induced events, have used a failure rate in the vicinity of 10^{-7} per item per year. For the RHR study, it was found that component failure and human error probabilities far exceeded any control system unreliabilities. For the feedwater study, using nuclear statistical data and no provision for maintenance, the original system unreliability was calculated to have a mean of 10^{-2} per year. The cumulative probability of only those feedwater failure modes involving the control system as a basic event was calculated to have a mean probability of occurrence of 10^{-4} per year. (Diss. Abstr. Int., B)

2163 COMPUTER CONTROL OF ADVANCED GAS REACTORS (AGR). Shimazu, A. (Fuji Electric Co. Ltd., Tokyo). FAPIG (Tokyo); No. 68, 238-242(Feb 1973). (In Japanese).

In the United Kingdom, control of nuclear power plants has progressed to the present use of process computers. The principal feature of the computer control system in the Hinkley Point B Power Plant is to actively utilize 16 CRT's to reduce the number of conventional instruments greatly. As a result, two units of the reactors can be operated by three operators. Each reactor-turbine-generator unit is controlled with a respective on-line computer. If a computer fails, that computer is automatically changed over to a stand-by computer. The system is designed to increase reliability by letting various points have redundancy in order to prevent shutdown due to failures. Functions of the system are plant monitoring and display, alarm analysis, plant data listing and recording, process control, and sequence monitoring. (JA)

2164 APPLICATION OF COLOR DISPLAY TO THE MONITORING OF NUCLEAR POWER PLANT OPERATION. Nakata, A. (Hitachi Ltd., Tokyo). Karyoku Hatsuden; 24: No. 2, 114-121(Feb 1973). (In Japanese).

Excellent man-machine communication methods are indispensable in monitoring operation of nuclear power plants from the viewpoint of safety. Process display has been put to practical use for this purpose because it is a method with which data are directly readable visually. The functions required of process display to improve the man-machine communication with operators are display of letters, patterns, trend graphs, special symbols, color display, blinking, and hard copy availability. Displayed data together with photos, which were obtained in the Shimane nuclear power plant, for which the H-7833 process display developed by Hitachi is installed, are briefly described. This display meets not only the above requirements for nuclear power plants but the requirements in application to other industries. Further development is expected. (JA)

2165 SYSTEM FOR MEASURING THE POSITION OF PWR NUCLEAR REACTOR CONTROL RODS. Lavergne, R. (Etablissements Merlin et Gerin, Grenoble, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 101, 5-14(May 1973). (In French).

The purpose of the control rods of PWR nuclear reactors is recalled together with the design of their command mechanism. The difficulties encountered when measuring the position of the rods are illustrated with examples. An original system is described for measuring the position of the rods, the system providing particularly accurate and reliable digital information. (FR)

2166 NUCLEAR REACTOR CONTROL SYSTEM. Ball, R. M. (to Babcock and Wilcox Co.). US Patent 3,793,141. 19 Feb 1974. Filed date 29 Sep 1972. 8p.

A nuclear reactor is described in which the neutron absorber

rods are positioned by fluid power applied in accordance with binary coded command signals in fluidic form and piped to a decoder within the reactor pressure vessel. (Official Gazette)

2167 REACTOR CONTROL SYSTEM. Dyke, T. W.; Harrison, W. C.; Davies, S. M. (to Canadian General Electric Co. Ltd.). Canadian Patent 906,688. 1 Aug 1972.

A secondary shutdown system for a water-moderated pressure-tube reactor is described. The system is based on the injection of soluble poison into the moderator. A reservoir of poison solution is separated from the primary coolant circuit by a relief valve. When the pressure of coolant becomes excessively high, coolant forces its way into the reservoir of poison, and forces the poison to rupture a bursting-disc and flow into the moderator. (CA)

2168 HYDRAULICS OF THE CONTROL SYSTEMS AND MECHANISMS. I. Ionaitis, R. R. pp 5-121 of Hydraulics of Nuclear Reactor Control and Safety Systems. Ionaitis, R. R. (ed.). Moscow; Atomizdat (1972). (In Russian).

In the first part of the book, devoted to questions of the hydraulics of the control and safety systems of reactors, questions of the hydraulics of the control system and mechanisms were examined. An analysis was given of the principal circuits of these hydraulic systems and mechanisms. The selection of criteria determining the motion of the hydraulic rods in channels was discussed. The results of the experimental study of the motion of the hydraulic rods were reported. A method was derived for the calculation of the hydraulic control systems. The results of the experimental studies, calculations, and construction of part of the hydraulic elements were described. (tr-auth)

2169 PREDICTION OF THE AUTOMATIC CONTROL CHARACTERISTICS OF THE BWR: ILLUSTRATED FOR THE WUERGASSEN NUCLEAR POWER PLANT. Beckmann, H. (Kraftwerk Union AG, Frankfurt am Main). (1974). vp. (In German).

From experts meeting of the task groups Thermodynamics and Fluid Dynamics and Reactor Physics of the KTG on requirements and present possibilities of predicting physics parameters of thermal and fast power reactors; Karlsruhe, Germany (29 Jan 1974).

The automatic control concept of the KWW has to meet the following requirements: certain system variables such as reactor pressure and filling level of the pressure vessel have to be kept at predetermined values; reactor power has to be related to the electric power transferred to the network; the automatic control device may not produce operating conductions which may cause a shutdown of the power plant; and time-consuming experiments for automatic control optimization must be avoided. (GE)

2170 CRACKS IN THE CONTROL ROD GUIDE TUBES OF THE VAK REACTOR. (1973). 19p. (In German).

From VGB conference: materials and welding techniques in nuclear power techniques, 1973; Duesseldorf, Germany (27 Nov 1973).

As a result of the detection of several cracks in the studs of the control rod guide tubes in the VAK reactor, more detailed investigations have been carried out of the materials in order to further determine their properties as a function of treatment and stressing. (GE)

2171 HYDRAULICS OF CONTROL AND SAFETY ROD DRIVES. II. Stobetskii, V. N. pp 122-176 of Hydraulics of Nuclear Reactor Control and Safety Systems. Ionaitis, R. R. (ed.). Moscow; Atomizdat (1972). (In Russian).

In the second part of the book, devoted to questions of the hydraulics of the control and safety systems of reactors, the characteristics of the construction of hydraulic drives for these systems is examined. The basic elements of the hydraulic drives are described and their calculation is given. A calculating plan and a mathematical model for the hydraulic drive are derived. The following characteristics of the hydraulic drive are examined: force characteristics, speed of response, and statistical and dynamic precision. (tr-auth)

2172 EQUIPMENT FOR CONTROL AND EMERGENCY PROTECTION DURING PHYSICAL START-UP OF REACTOR BN-350. Dubovskii, B. G.; Bondarenko, V. V.; Vaimugin, A. A. At. Energ. (USSR); 36: No. 2, 104-107(Feb 1974). (In Russian).

There is described highly sensitive start-up equipment for reactor BN-350 control and emergency protection during core assembly and physical start-up experiments. The start-up equipment controlled the reactor from the moment the first fuel charge elements were placed in the core. A power current meter controlling the change in neutron flux in the reactor from $k_{eff} \approx 0.97$ is described. The instrument made it possible to reliably control the coupling between rods of the safety control system and executing mechanisms, and change neutron flux when measuring physical power levels. At present, the instrument is part of standard control equipment for reactor operation in a power regime. Certain results of measuring reactivity with a reactivity meter are presented. It is shown that such an instrument makes it possible to obtain rapid information on reactivity change to more fully satisfy safety requirements during reactor operation. The reactivity meter is also included in standard safety control system equipment and is used when the reactor is operated in a power regime. Equipment used during physical start-up to calibrate safety control system units and measure reactivity effects by an asymptotic period determination method are described. (4 references) (auth)

2173 PROBLEMS OF RELIABILITY ANALYSIS IN NUCLEAR POWER PLANT TECHNOLOGY. Hoertner, H. (Technische Univ., Munich). (1974). vp. (In German).

From second information meeting of the Laboratorium fuer Reaktorregelung und Anlagensicherung; Garching, Germany (16 Jan 1974).

For a PWR type reactor, the overall analysis of the safety systems is described for the case of a "Big Leak in the Reactor Cooling System." The analysis includes not only the reflooding of the reactor pressure vessel and the emergency cooling, but also the reactor control system and the power supply. (GE)

2174 RELIABILITY STUDIES ON ELECTRONIC COMPONENTS. Goßner, S. (1974). vp. (In German).

From second information meeting of the Laborstorium fuer Reaktorregelung und Anlagensicherung; Garching, Germany (16 Jan 1974).

An accurate reliability study of a nuclear power plant also includes the analysis of relevant electronic components within the safety system. Error analyses of electronic parts of re-control systems are presented. Knowing the reliability of single parts, conclusions can be made as to the reliability of the whole system. Buffer amplifiers and limit-value indicators are dealt with in particular. (GE)

2175 REACTIVITY AND POWER DISTRIBUTION CONTROL OF NUCLEAR REACTOR. Fischer, D. L.; Channons, F. R. (to General Electric Co.). US Patent 3,799,839. 26 Mar 1974. Filed Date 7 Jan 1971. 20p.

This describes a spatial distribution, amount, density and configuration of burnable poison to control a pre-determined amount of excess reactivity and to maintain a constant or stationary power distribution during the operating cycle of a nuclear reactor core. In the illustrated embodiment of the invention the burnable poison is distributed throughout the core in a relatively small number of the fuel rods. In a preferred embodiment of the invention plutonium fuel is used in conjunction with the burnable poison to improve local power distribution and control margin and as an effective means for utilizing plutonium fuel. (Official Gazette)

2176 FUSE FOR NUCLEAR REACTOR. Schively, D. P. (to United States Atomic Energy Commission). US Patent 3,795,580. 5 Mar 1974. Filed Date 19 Oct 1972. 4p.

A fuse for nuclear reactor shutdown is provided which employs a fusible metal plug disposed within an elongated capsule at its upper extremity to upwardly displace, upon fusing at a preselected reactor excursion temperature, a liquid neutron absorber from the bottom portion of the capsule into the central portion which substantially corresponds to the core region of the reactor. The present fuse is placed within a core duct of the reactor. A method for shutting down a nuclear reactor is also provided wherein liquid neutron absorbing poison is introduced into the reactor core region by volume displacement. (Official Gazette)

Nuclear Power Plant Economics

Refer also to abstract 1885.

2177 STATE OF ATOMIC ENERGY INDUSTRY IN FISCAL 1971. Vision on the Period of Atomic Power Supply. Araki, T.; Yamashita, Y.; Minakami, T. (Japan Atomic Industrial Forum, Inc., Tokyo). Genshiryoku Chosa Jiho; No. 23, 1-36(Mar 1973). (In Japanese).

The results of survey on the atomic energy industry in Japan by Japan Atomic Industrial Forum for the fiscal year 1971 are presented. Investments in research and development and in facilities both increased remarkably from the highest value recorded in the previous year; red figures in the industry still remained, however. The total expenditures were Y233,400 million, 1.4 times as much as that in the preceding year. The aggregate sales in mining and

manufacturing were Y68,700 million, 1.3 times as high. The total personnel engaged in atomic energy business are 19,050, 1.3 times as many as that in the previous year. (JA)

2178 PRESENT AND FUTURE OF NUCLEAR RESEARCH AND DEVELOPMENT IN JAPAN. Murata, H. (Japan Atomic Energy Research Inst., Tokyo). At. Jap.; 17: No. 5 Suppl., 66-72(May 1973). (In Japanese).

At present atomic energy has entered an environment-sensitive phase, phase III, involving inquiries into economics of the past, reactor safety and preservation of the environment. Japan Atomic Energy Research Institute is conducting various experiments, including excess-reactivity tests, ECCS test and so on. The amount of money provided by the Government for research and development on reactor safety for the LWR has sharply risen since 1973. For LWR, desalination and space heat as well as fish farming, the use of hot water released from nuclear power plants is being studied. Utilization of radiation in chemistry such as the gas phase polymerization of ethylene, and in medicine such as the use of neutron irradiation for treatment of brain tumor, have been developed. (JA)

2179 FOURTH NUCLEAR PROGRAMME AND ITS IMPACT ON NUCLEAR INDUSTRY IN GERMANY. Harde, R. (International Atomreaktorbau GmbH, Bensberg, Ger.). At. Jap.; 17: No. 5 Suppl., 73-93(May 1973).

Essential points in reactor development and fuel cycle in the fourth nuclear programme are considered. The government expenditures for reactor development are concentrated on two systems: the gas cooled high temperature reactors and the sodium cooled fast breeder. The only other reactor system expected to receive sizable funding is the light water reactor, to a large degree for its application as ship reactor. Obvious emphasis is placed on uranium enrichment, fuel reprocessing and waste storage in fuel cycle development. The role of nuclear energy in energy production and the nuclear industry in Germany are described. The use of electricity increases much faster than the total consumption of primary energy. (JA)

2180 CONSULTANT COMMISSION FOR THE PRODUCTION OF NUCLEAR ELECTRICITY. Laurent, M. Develop. Ind. Sct.; No. 15, 29-33(May 1973). (In French).

The current situation and future outlook for ordinary water reactors are studied. The commission recommends an acceleration of the French nuclear electricity program. The commission also requires that work is undertaken to guarantee the safety of these installations as well as the protection of individuals, and that problems concerning the transport of materials and export financing problems are resolved. The interactions between the supply and demand of fissile materials, and between the volume and distribution of the program in terms of the various types of reactors (those currently used and those foreseen for the future such as sodium cooled breeders and high temperature reactors), are considered with the year 2000 at the horizon. (FR)

2181 NUCLEAR ENERGY. Nazzer, D. B. (Deuterium of Canada, Ltd., Sydney). Trans. Can. Inst. Mining Met.; 75: 273-276(1972).

The development of Canada's nuclear power program from its inception is briefly reviewed. The engineering aspects of the CANDU concept are compared with those of the American BWR's and PWR's. It is noted that the Canadian system at present has no need for enriched fuels and in particular for recovered plutonium, thus simplifying the spent fuel storage problem in Canada. Projections are given for costs and nuclear capacity in Canada to 1990. (CA)

2182 INDUSTRIAL DEVELOPMENT PROSPECTS IN THE UK. Report to Session 5. Nicholsen, R. L. R. London; British Nuclear Forum (1973). 7p.

From fifth foratom congress on nuclear power plant in Europe: yesterday, today, tomorrow; Florence, Italy (14 Oct 1973).

Factors for and against the adoption of nuclear power in the UK are enumerated. The second nuclear power program provides for 5 AGR type stations for 1976. Cumulative installed capacity will be doubled by 1975, trebled by 1980, after which the installation rate will increase sharply. The total amount of materials and services to meet this program are tabulated, and the installed and predicted capacities for the uranium products, enriched uranium, fuel fabrication and reprocessing, are briefly summarized. Cause of difficulty in completion of stations are indicated. European market prospects are briefly considered. (UK)

2183 PROCEEDINGS OF THE AMERICAN POWER CONFERENCE. Volume 35. Thirty-fifth Annual Meeting, Chicago, Illinois, May 8-10, 1973. Chicago; Illinois Institute of Technology (1973). 1278p. (CONF-730582-). $20.00.

One hundred thirty papers were presented at the conference. Of the total, abstracts were prepared for 33; 93 were not in scope for NSA; and two appeared previously in NSA. The unusual length of a paper on lightning protection for industrial power systems was cited with only an abstract furnished. (MCW)

For abstracts of individual papers see: 1754, 1849-1853, 1869-1874, 1898-1900, 1917, 1918, 1956-1960, 2089-2092, 2135, 2136, 2152, and 2192-2195.

2184 OUTLOOK FOR INDUSTRIAL DEVELOPMENTS. Rozenholc, M. (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 102, 54-67(Jul 1973). (In French).

From fifth foratom congress on nuclear power plants in Europe; Florence, Italy (15 Oct 1973).

The various factors favoring or discouraging nuclear energy in relation to classical energy in France are examined: technical factors associated with the power of individual plants, the energy transport network, the utilization of reactors, site problems, factors linked with scientific and technological research, and national energy policy and economic factors. The power requirements and reactor start-ups envisaged in France from the present day up until 1980 are indicated. The nuclear power investments are considered in terms of kW(e). The different types of reactor are recalled together with the nominal powers envisaged to meet the energy requirements. The main materials ordered in the French program are described as well as the corresponding components. The production capacity for these materials and components is given from now until 1980. Export orders are estimated. The problems posed by the export of complete plants and components are cited: financial aspects, technical norms and references. (FR)

2185 1972: YEAR OF INTERIOR CONSOLIDATION FOR THE KWU. At. Inform.; No. 8, 11-13(1973). (In German).

Short surveys on the business year 1972 are given in extracts from the business report for the Kraftwerk Union AG (KWU) and the KWU daughter society INTERATOM on the fast sodium-cooled reactor (SNR) project. Problems of nuclear energy and its impact on the energy policy, discussed by a committee on measures to promote exports, some tenders invited by CERN, and the foundation of a "World Energy Bank" including nuclear energy are briefly discussed. (GE)

2186 CHOICE OF A REACTOR SYSTEM. First Report Session 1973-1974. London; Her Majesty's Stationery Office (1974). 7p.

The enquiry by the House of Commons Select Committee into the choice of a reactor system for the next stage of Britain's nuclear program is presented. The size and time scale of the program are discussed. Safety aspects of a proposal to install PWR reactors are examined, and the economics of such systems are considered. Among alternative medium-term systems the SGHWR is discussed; and the possibility of collaboration between Canadian and British industry and the exchange of information on CANDU and the SGHWR is referred to. (UK)

Reactor Fuel Cycle Economics

Refer also to abstract 1883.

2187 EVALUATION OF THE RELOADING PLAN FOR A FAST REACTOR. Zamparo, G. Ing. Nucl.; No. 1, 9-21(1973). (In Italian).

The cost of nuclear energy depends on many factors closely bound to the fuel cycle. In the present study the calculations are based on the core of a fast reactor for a 1000 MW(e) nuclear power plant. The results of calculations to evaluate the fuel costs using several reloading plans are reported. For a typical cycle the incidence of various parameters on the energy cost is examined. 24 references. (tr-auth)

Reactor Licensing and Regulation

2188 (DOCKET-50133-169) HUMBOLDT BAY POWER PLANT, UNIT 3. Quarterly Status Report, January-March 1974. (Pacific Gas and Electric Co., San Francisco, Calif. (USA)). 26 Apr 1974. 24p. Dep. NTIS $4.25.

A status report is presented on the geologic and seismologic investigations, liquefaction and dynamic response of site soils, and the seismic design analyses of soils, reactor components, and structures. (FS)

2189 (DOCKET-50409-111) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report for January 1974. (Dairyland Power Cooperative, La Crosse, Wis. (USA)). 1974. 23p. Dep. NTIS $4.25.

The reactor was critical for 732.6 hours, with the turbine-generator connected to the DPC grid for 715.3 hours. One reactor scram occurred during a scheduled shutdown for AEC Reactor Operator License Examination. Two reactor criticals were pulled for the AEC Reactor Operator License Demonstrations. No problems were encountered which required a curtailment or reduction in reactor power. Off-gas released during the month averaged 700 μCi/second during reactor operation. An Operating Summary is included. (auth)

2190 (RDT-STATUS-3-74) BIMONTHLY STATUS REPORT: RDT STANDARDS. Summary as of March 29, 1974. (USAEC Division of Reactor Development and Technology, Washington, D. C.). 30 Apr 1974. 49p. RSO.

2191 PRESENT STATUS OF OFFICIAL TECHNOLOGY REGULATIONS FOR NUCLEAR POWER PLANT. Chizaki, Y. (Japan Electric Association, Tokyo). Genshiryoku Kogyo; 19: No. 5, 44-48(May 1973). (In Japanese).

The regulations and guidelines on nuclear power plants were published previously after studies on the subject by an experts' committee in the Japan Electric Association. The difference in nature between the regulations and guidelines and the MITI's similar standards enforced by law is first explained. A summary description of the regulations and guidelines is presented, and finally the subjects for future study are given. While the MITI's standards are ministerial ordinance, the regulations and guidelines are essentially civil ones which supplement the MITI's standards in more concrete form. The items covered are inspection and test of nuclear power facilities, their safety design and operation, etc. (JA)

2192 STANDARDIZATION IN NUCLEAR POWER. Muntzing, L. M. (Atomic Energy Commission, Washington, DC). Proc. Amer. Power Conf.; 35: 278-284(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The present expectations for nuclear power will not be achieved without significant changes of concept in the design, construction, and regulation of nuclear power plants and facilities. The practice of having wide design variations among individual nuclear power plants is necessary for the developmental stage, but the demanding goals for quantity production will require standardization. (MCW)

2193 NUCLEAR PLANT STANDARDIZATION: BOON OR BANE. Ward, J. E. (Sargent and Lundy Engineers, Chicago). Proc. Amer. Power Conf.; 35: 285-293(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

Nuclear standardization must be approached cautiously, so that benefits of faster licensing and early start-up of much needed nuclear generating capability can be achieved without too great a penalty in design stagnation. Innovation must not be penalized by the regulators to the point where it is stifled altogether, for standardization can perpetuate errors as well. (MCW)

2194 CRITICAL REVIEW OF LICENSING PROCEDURES AND THEIR EFFECT ON ELECTRIC SUPPLY AND CAPACITY PLANNING. Burstein, S. (Wisconsin Electric Power Co., Milwaukee). Proc. Amer. Power Conf.; 35: 294-299(1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

Resolutions of licensing procedural difficulties exist, but little has been done about them. Almost all the activity, what little there was, was directed in reaction to settle some short-term, immediate crisis. Almost nothing, save perhaps the standards program, has been directed toward long-term procedural reform that everyone can look forward to with confidence and comfort. (MCW)

2195 ENVIRONMENTAL REPORT: ITS IMPACT ON THE LICENSING PROCESS. Philbin, T. W. (Environmental Analysts Inc., Garden City, NY). Proc. Amer. Power Conf.; 35: 300-309 (1973).

From The American Power conference; Chicago, Illinois, USA (8 May 1973). See CONF-730582-.

The present status of the process of environmental report preparation is described. The development of the report is traced from its pre-NEPA beginnings to the present. A description of the present requirements as reflected in the new regulatory guide, Preparation of Environmental Reports for Nuclear Power Plants, and some experiences of applicants are described. Comments from an industry point of view are given. (MCW)

2196 PRELIMINARY DECISIONS AND PARTIAL LICENSES AND THEIR RELATIONSHIP TO THE INDUSTRIAL AND ATOMIC ENERGY LAW: THEIR BINDING FORCE FOR SUBSEQUENT DECISIONS SUBJECT TO LEGISLATION. 155th Colloquium on December 15, 1972. Salzwedel. Z. Wasserrecht; 12: No. 2, 85-92(1973). (In German).

Aspects of the water legislation which have the effect on the industrial and atomic energy law are presented. A basis is provided for the discussion of the following subjects: development of legal provisions such as preliminary decisions and the granting of partial licenses; the extent to which provisions of this kind are binding for subsequent final decisions and licenses; the relationships between preliminary decisions and partial licenses; and subsequent decisions subject to water legislation. (GE)

GENERAL

Energy Utilization and Economics

Refer also to abstracts 1754, 2194, 2367, and 2368.

2197 (KFK-1915) HYDROGEN PRODUCTION FROM WATER BY REACTOR HEAT. Dorner, S.; Schnurr, W. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Feb 1974. 46p. (In German). Dep. NTIS (U. S. Sales Only) $5.50.

The already proposed or known procedures of obtaining hydrogen by means of reactor heat are discussed. The critical review shows that so far an adequate procedure cannot be proposed; therefore, we attempted to indicate novel processing means using an extended process systematics. New working hypotheses can be established on the basis of this process systematics. (auth)

2198 (ORNL-NSF-EP-68) TOTAL ENERGY USE FOR COMMERCIAL AVIATION IN THE U. S. Hirst, E. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 15p. Dep. NTIS $4.00.

The total energy impacts of commercial aviation in the United States are shown. Direct fuel use by commercial airplanes (1080 trillion Btu in 1971) amounts to 6% of direct fuel use for all domestic transportation, 1.6% of the total national energy budget. Indirect energy requirements are one-third as great as the direct fuel use. Thus, total energy demand for domestic commercial aviation in 1971 was 1450 trillion Btu, 2% of national energy use. Direct fuel savings due to adoption of airline conservation measures can be increased by one-third to account for the indirect energy savings. Some conservation measures, such as a reduction in short-haul flights, are likely to have larger energy savings, because short-haul flights involve higher maintenance costs, greater airport use, and higher passenger service costs on a passenger-mile basis than do longer flights. Other measures, such as reducing cruise speeds, are likely to have relatively small indirect energy savings. In all cases, however, the direct fuel savings can be increased by 20% to account for the energy costs associated with crude oil extraction, transportation, and refining. (MCW)

2199 (SLA-74-90) PHOTOGRAPHIC TECHNIQUE TO DETERMINE THE APPARENT ENERGY DISTRIBUTION OF THE SOLAR AUREOLE. Robertson, C. E.; Banker, J. H. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 11p. Dep. NTIS $4.00.

Photographic film, after processing, forms silver in proportion to the amount of solar energy which falls upon the film during exposure. The relationship between the amount of solar energy and the amount of silver is determined through sensitometry. (auth)

2200 (SLA-74-148) PROPOSAL FOR IMPROVED DEEP DRILLING. Newsom, M. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 27p. Dep. NTIS $4.50.

There is increasing interest in the development of methods of drilling for oil and gas at depths below 5000 feet. The program proposed is an attempt to reduce both the time and the costs associated with deep well drilling. The methods described comprise (1) shocks generated by electrical detonations and subsequent cavitation, (2) the use of a continuous-belt drill bit, (3) a terradynamics drilling system, and (4) nondestructive testing and materials analysis. (auth)

2201 SITU COAL BED GASIFICATION. Higgins, G. H. (to United States Atomic Energy Commission). US Patent 3,794,116. 26 Feb 1974. Filed date 30 May 1972. 12p.

Deeply buried relatively thick coal bed formations are fractured explosively. Reactant input conduits communicating with upper portions of the fragmented coal zone and product withdrawal conduits communicating with lower portions are provided. The uppermost layer of the fragmented zone is ignited as by injection of oxygen and fuel gas from a surface plant while the product conduits are closed off to raise the operating pressure in the fragmented zone to balance hydrostatic pressure so that the fragmented zone comprises effectively a pressurized reaction vessel. Water or steam together with regulated amounts of oxygen are then introduced while reaction products are withdrawn at a rate at which operating pressure is maintained so that a relatively higher temperature reaction zone layer is reacted in the upper layer to travel progressively downward. A graduated lower temperature region precedes the higher temperature zone. Various gasification reactions occur in the reaction zones with the net overall products being methane and CO_2 with relatively little up to varying amounts of carbon monoxide and hydrogen appearing in the reaction product gas. Processing to remove CO_2 and react the carbon monoxide and hydrogen if deemed necessary is done at the surface yielding a high caloric value fuel gas suitable for pipeline or for synthesis uses. (Official Gazette)

Information Handling

Refer also to abstract 1728.

2202 (AERE-R-7673) ON-LINE SEARCHING OF COUNCIL OF EUROPE CONVENTIONS AND AGREEMENTS: A STUDY IN BILINGUAL DOCUMENT RETRIEVAL. Price, N. H.; Bye, C.; Niblett, B. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jan 1974. 16p. Dep. NTIS (U. S. Sales Only) $4.00. UK 50 pence.

The Agreements, Conventions and Protocols concluded between the Member States of the Council of Europe are a largely self-contained set of documents admirably suited for a small-scale full-text retrieval system. They cover a wide range of subject matter including economic, social, cultural, scientific, legal and administrative topics. The best known and the most important of the Conventions is that concerned with the Protection of Human Rights and Fundamental Freedoms. A feature of particular interest is that English and French are the official languages of the organization and thus the documents are available in both these languages. The total size of the text is some 200,000 words in each language. The paper describes the main features of the computer programs as implemented on the IBM 370/165 at Harwell, and includes results of typical search enquiries. (MCW)

2203 (AWRE-44-47-32) FACILITIES PROVIDED BY THE ALDERMASTON MECHANICAL CATALOGUING AND ORDERING SYSTEM (AMCOS) USED IN THE AWRE LIBRARY. MacSwiney, J. F. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). Feb 1974. 48p. Dep. NTIS (U. S. Sales Only) $4.50. UK £1.

2204 (CONF-740402-9) SERVICES TO THE CTR COMMUNITY BY THE RADIATION SHIELDING INFORMATION CENTER. Roussin, R. W.; Trubey, D. K.; Maskewitz, B. F. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. 12p. Dep. NTIS $4.00.

From topical meeting on technology of controlled nuclear fusion; San Diego, California, USA (16 Apr 1974).

The Radiation Shielding Information Center, established in 1962 to collect, package, analyze, and distribute information, computer codes, and data in the area of radiation transport related to fission, is now being utilized to support fusion reactor technology. The major activities include: (1) operating a computer-based information system and answering inquiries on radiation analysis, (2) collecting, checking out, packaging, and distributing large computer codes, and (3) evaluated and processed data libraries. The data packages include multigroup coupled neutron-gamma-ray cross sections and kerma coefficients, other nuclear data, and radiation transport benchmark problem results. Future plans include clearinghouse functions for CTR evaluated and processed multigroup data libraries. (auth)

2205 (DP-929(Rev. 2)(Supp. 2)) PUBLICATIONS, 1973. Hilborn, H. S. (comp.). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. (USA). Savannah River Lab.). Feb 1974. Contract AT(07-2)-1. 21p. Dep. NTIS $4.00.

The compilation includes research and development reports, journal articles, contributions to books, computer programs, and other items published by Du Pont under its contract with the Atomic Energy Commission, through 1973. Bibliographic, subject, and author listings are presented. (MCW)

2206 (EUR-5051) AUTOMATIC CLUSTERING TECHNIQUES IN INFORMATION RETRIEVAL. Fritsche, M. (Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). 1974. 145p. Dep. NTIS (U. S. Sales Only) $9.25. EUR B.Fr. 185.-.

Thesis. Submitted to Univ. of Stuttgart.

The present study is a state-of-the-art report on automatic clustering techniques which reviews the research performed in the field since 1967. Although emphasis was given to methods applicable in the field of information science, many approaches can be used in other applications as well. (auth)

2207 (ORNL-4951) ON-LINE CONVERSATIONAL RETRIEVAL SYSTEM FOR ORCHIS TEXT-ORIENTED DATA BASES USER'S MANUAL. Singletary, V. A. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 49p. Dep. NTIS $5.45.

The user guide to the ORLOOK computer program includes descriptions of information files, methods of communication, program functions, control command syntax, and frequently used terminology. The program was developed as an integral part of the Oak Ridge Computerized Hierarchical Information System (ORCHIS) to facilitate retrospective searches of online linear files. It executes in the timesharing teleprocessing environment of the IBM 360 Model 75 computer at the Oak Ridge National Laboratory. Subset files produced from its logical operations can be searched, combined, copied to online storage for subsequent ORCHIS manipulation, and output to the user typewriter terminals or to the computer system printer. (auth)

2208 (TID-4028-S1-R1) USAEC TRANSLATION LIST INDEX, 1970–1973. Gardner, H. L. (comp.). (USAEC Technical Information Center, Oak Ridge, Tenn.). Apr 1974. 211p. Dep. NTIS $7.60.

The Author Index lists the authors of published literature and reports. The Report Number Index contains the original report numbers for foreign language reports that have been translated and also includes all numbers assigned to translations issued as reports. Titles of journals, books, and published conference proceedings that have been translated cover-to-cover or in part are listed alphabetically in the Source Index. Translations of patents are listed, alphabetically by country, in the Source Index under Patents. (MCW)

2209 TERMS AND DEFINITIONS OF NUCLEAR SCIENCE AND TECHNOLOGY IN SIX LANGUAGES. Berlin; Beuth (1973). 205p. (In several languages).

This booklet contains the accepted German standardized terms and definitions of the sheets DIN 25401 "Nuclear science and technology." The English, French, Italian, Dutch and Russian terms are listed below the appropriate German terms, which are arranged in alphabetical order, and there is an alphabetical index in each of these languages. The coordination of the terms used in the various languages and the standardization of the definitions on an international level have been carried out by several groups of specialists within the framework of the ISO/TO 85 for nuclear science and technology. There are some cases where the definition given in the German standard DIN 25401 differs from that contained in the international standard ISO 921/1972. A classification scheme for nuclear reactors (DIN 25402) is given in the appendix. (GE)

Law

Refer also to abstract 2202.

2210 RADIATION LEGISLATION. Koren, K. (Statens Institutt for Straalenhygiene, Oslo). pp 160-167 of Straalefysikk, Straaleterapi, Straalehygiene, Straalebiologi. Klokk, A. (ed.). Oslo; Statens Institutt for Straalehygiene (1973). (In Norwegian).

As early as 1923 a proposal was made by Norsk Forening for Medisinsk Radiology for regulations to protect patients, doctors, and nurses in x-ray and radium treatment. The legal form was however not submitted to the National Assembly (Storting). The first Norwegian law regulating the use of radium and ionizing radiation was passed on June 18th, 1938, and the laboratory which is now Statens Institutt for Stralehygiene (SIS) was established the same year. Radiation protection regulations are further defined in a Royal Resolution of November 21st, 1947, which among other rules requires annual medical inspection of radiation workers. Another Resolution of September 25th, 1953 establishes the duties of SIS in inspection, planning, dosimetry, and education. Norway's ratification in 1961 of ILO's Convention nr. 115 on protection of workers against radiation gives its recommendations the status of Norwegian Law. The Law on Atomic Energy of May 12th, 1972 regulates the granting of concessions, licensing, inspection etc. of reactors, nuclear ships and other nuclear plants, and the transport of radioactive materials. (NO)

2211 DECONTAMINATION AND DEMOLITION OF DISUSED BUILDINGS CONTAMINATED WITH RADIOACTIVITY. II. Legal Aspects. Butler, M. J. (National Radiological Protection Board, Harwell, Eng.). Radiol. Prot. Bull.; No. 6, 7-10(Jan 1974).

An outline discussion is presented of the legal problems associated with the discovery that a site due for or subsequent to, redevelopment is contaminated with radioactivity. Two examples from NRPB records are used in the discussion of levels to which the radioactivity should be reduced, who should certify that the appropriate level has been achieved, and who should bear the expense. (UK)

2212 APPLICATION FOR PERMISSION TO INTERVENE BY THE GOVERNMENT OF FIJI FILED IN THE REGISTRY OF THE INTERNATIONAL COURT ON JUSTICE ON MAY 16, 1973. pp 1-16 of International Court of Justice. Nuclear Tests Case, Australia vs. France. Volume 3. Canberra; Australian Government Publishing Service (1973).

2213 APPLICATION BY FIJI FOR PERMISSION TO INTERVENE. Order of July 12, 1973 of the International Court of Justice. pp 19-20 of International Court of Justice. Nuclear Tests Case, Australia vs. France. Volume 3. Canberra; Australian Government Publishing Service (1973).

2214 REQUEST BY THE GOVERNMENT OF AUSTRALIA FOR PROVISIONAL MEASURES OF PROTECTION. pp 3-140 of International Court of Justice. Nuclear Tests Case, Australia vs. France. Volume 2. Canberra; Australian Government Publishing Service (1973).

A case is presented by the Australian government to the International Court of Justice for provisional measures of protection from French nuclear explosions. The case outlines rights to be protected, the grounds of the request, and the consequences of further atmospheric testing of nuclear weapons. Interim measures proposed are given. Scientific reports on the effects of ionizing radiation are tabled. (auth)

2215 ORDER OF JUNE 22, 1973 of the International Court of Justice. pp 235-262 of International Court of Justice. Nuclear Tests Case, Australia vs. France. Volume 2. Canberra; Australian Government Publishing Service (1973).

The decision of the International Court of Justice in the Nuclear Tests case is given. The opinions of some of the dissenting judges are presented. (auth)

2216 TRANSCRIPT OF ORAL PROCEEDINGS FOR MAY 21, 22, 23, AND 25, 1973. pp 143-232 of International Court of Justice. Nuclear Tests Case, Australia vs. France. Volume 2. Canberra; Australian Government Publishing Service (1973).

The transcript is given of the proceedings of the Nuclear Tests Case instituted on 9 May 1973 by Australia against France. Evidence is presented of the harmful effects of ionizing radiation to human populations and the consequences of radioactive fallout. (auth)

Management

2217 (APED-5525) CRITICAL PATH SCHEDULING: INTRODUCTION, CRITIQUE, AND EXTENSIONS. Steward, D. V. (General Electric Co., San Jose, Calif. (USA). Atomic Power Equipment Dept.). Jul 1967. 48p. (67-APE-4).

A scheduling technique designed to cope with the fast, competitive pace of modern-day technology was developed. The basic technique is called Critical Path Scheduling (CPS). A revised concept was developed as a means for planning the best cost schedule when given the costs of expediting each activity. This variation is the Critical Path Method. The U. S. Navy Special Projects Office developed PERT (Project Evaluation and Review Technique). PERT added to the basic CPS concept the notion of the probability of meeting the schedule as a function of the uncertainty in the times required to complete each of the activities in the project. (MCW)

2218 (BDX-613-1077) AUTOMATED SCHEDULING OF MANUFACTURING RESOURCES. Technological Spinoff Report. Hoppen, W. G. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1974. Contract AT(29-1)-613. 26p. Dep. NTIS $4.50.

To effectively utilize manpower, equipment, and facilities in production, two major factors must be known: the current in-process status of product and the required date for the finished product. By automatically computing production and inspection hours and comparing the results to required dates and resource capacities, it is possible to provide a daily priority plan for every production load center. The automated process characterizations and control techniques are given that provide a five-day finite plan for 100 percent of the capacity of each load center in a manufacturing operation producing mechanical and electronic assemblies under contract for the U. S. Government and involving approximately 13,000 active part numbers. (MCW)

2219 (COO-2330-1) NUCLEAR TECHNICIAN MANPOWER IN THE WESTERN UNITED STATES. (Western Interstate Nuclear Board, Lakewood, Colo. (USA)). 25 Feb 1974. Contract AT(11-1)-2330. 19p. Dep. NTIS $4.00.

The work performed by the Western Interstate Nuclear Board (WINB) is described in developing a survey population for a nuclear technician supply and demand study being conducted by the U. S. Atomic Energy Commission in the Western United States. WINB efforts in identifying actual and/or potential employers and sources of supply of nuclear-related technicians and in preparing mailing lists for the USAEC study are discussed. (auth)

2220 PLANNING A NUCLEAR MEDICINE SERVICE. Harris, N. J.; Bennett, L. R. (Univ. of California, Los Angeles). Hospitals; 47: 84-94(16 Oct 1973).

Nuclear medicine is a field in which technological advances are rapid and the demand for procedures is expanding, making planning

difficult. Planning will be more successful, facilitating operation of the nuclear medicine service, if it includes the steps of defining the service's objectives and functions and its role in the hospital's organization, projecting the number of procedures and the amount of revenue expected per year, and determining the equipment and the space needed to meet the projected work load. All planning for a nuclear medicine service must allow flexibility to accommodate rapid future growth. (auth)

2221 EDUCATION AND TRAINING IN RADIATION PROTECTION. Rasmussen, C. E. (Interuniversity Reactor Inst., Delft, Netherlands). pp B.3.1-B.3.3 of Safety Measures in Nuclear Research. Fieuw, G. (ed.). Mol, Belgium; Centre d'Etude de l'Energie Nucleaire (1972).

From tripartite meeting; Brussels, Belgium (19 Apr 1971). See CONF-710472-.

The historical development in Holland of study courses in radiation protection is reviewed. Courses currently given at the Interuniversity Reactor Institute at Delft are described. These courses are used to certify that personnel have attained the status of "qualified expert" in the radiation protection procedures to be followed during the handling of radioactive materials. (LCL)

2222 MULTI-YEAR RESEARCH AND EDUCATION PROGRAM OF THE JOINT RESEARCH ESTABLISHMENT OF THE EUROPEAN COMMUNITY: DIRECT ACTION PART. Technol.-Nachr. Sonderienst-Program.; No. 75, 1-14(Oct 1973). (In German).

The conclusions of the cabinet council of the European Communities in June 1973 on the multi-year research program for the Joint Research Establishment are presented and explained, as well as the allocations of budget and personnel for the period 1973-77 given in tabular form. The main points of the program are: long-term energy supply, generation of hydrogen by chemical reaction cycles, treatment and disposal of radioactive wastes, plutonium/transplutoniums, solids/materials science, pulsed neutron sources, reactor safety, applied information sciences, reference substances, environmental protection, training as well as contract research. (GE)

2223 SOCIETY-ORIENTED LARGE-SCALE RESEARCH. Lehmann, W. M. (Kernforschungszentrum, Karlsruhe, Ger.). Fridericiana; No. 13, 7-18(Nov 1973). (In German).

This review article gives a brief survey of the activities of the Nuclear Research Centre Karlsruhe. The various scientific institutes and departments are mentioned along with the research work carried out within the framework of the numerous projects which are discussed in some detail. Organizational questions and the cooperation with other countries as well as with the University of Karlsruhe are also touched upon. (GE)

2224 MULTI-YEAR RESEARCH AND TRAINING PROGRAM OF THE JOINT RESEARCH ESTABLISHMENT OF THE EUROPEAN COMMUNITY: INDIRECT ACTION PART. Technol.-Nachr. Sonderienst-Program.; No. 76, 1-12(Oct 1973). (In German).

A summary of all expenses of the research and development program concluded in June is given, as far as this has been taken over by external contract partners and not by Euratom itself. This particularly concerns the reprocessing of plutonium (with long-term estimate until 1985), reactor control and safety, transportation problems of plutonium-contained fuels, plutonium recycle within a planned network of plutonium charged power plants, HTR technology (in particular irradiation investigations, fast reactors, and materials testing reactors). (GE)

2225 NUCLEAR ENERGY: ITS INTERACTIONS WITH MINING AND METALLURGY. Hugo, J. P. J. S. Afr. Chem. Inst.; 73: No. 3, 91-98(Oct 1972).

It is shown that the utilization of nuclear energy, in its worldwide and local contexts, must perforce interact with mining and metallurgy in South Africa to a steadily increasing degree. It is important that South Africa's mineral resources be efficiently exploited and utilized. Tables showing estimated world resources and world demand for uranium are given. Estimated costs and markets are discussed. The need for the cooperation of metallurgists and miners in the promotion of future nuclear industry is stressed. (auth)

2226 NEEDS OF ACADEMIC RADIOLOGY IN THE SEVENTIES. Report of the Advisory Committee on Academic Radiology of the Association of University Radiologists and Society of Chairmen of Academic Radiology Departments. Radiology; 111: No. 1, 223-232(Apr 1974).

This report establishes the needs of academic radiology by identifying and separating the academic functions - resident training, graduate and undergraduate teaching, and research - from the patient care function. According to the subdiscipline involved, an academic radiology department needs 77 to 120% more staff physicians than a community hospital; 29 to 192% more space, 33 to 56% more investment in equipment, and 0.5 to 2.5 additional full-time equivalents in supporting staff. It must also bear the costs of salaries and benefits for residents. It is proposed that research vital to the future of radiology and important to medicine as a whole be funded separately on a competitive basis. (auth)

Mathematics and Computers

2227 (AERE-R-7587) DESIGN OF HARDWARE SIMULATORS FOR COMPUTER INPUT/OUTPUT CHANNELS. Purches, M. J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Feb 1974. 21p. Dep. NTIS $4.25. UK 50 pence.

Difficulties in implementation of new designs of computer peripherals can be eased significantly by employing hardware computer simulators for many of the tests. The report identifies some situations where simulators can be gainfully employed; makes general design suggestions; and describes in detail two simulators in regular use at Harwell. (auth)

2228 (ANL-8056) EMPIRICAL INVESTIGATION OF REORDERING AND DATA MANAGEMENT FOR FINITE ELEMENT SYSTEMS OF EQUATIONS. Bolstad, J. H.; Leaf, G. K.; Lindeman, A. J.; Kaper, H. G. (Argonne National Lab., Ill. (USA)). Sep 1973. Contract W-7405-109-eng-38. 51p. Dep. NTIS $4.00.

Certain empirical aspects of the solution of sparse symmetric positive definite systems of linear equations which arise in the approximate solution of second-order elliptic partial differential equations by the finite element method are discussed. The equations are solved using a direct method (LDLT factorization). The structure of the coefficient matrix and the desire to reduce storage and computational requirements necessitate a reordering of the rows (and corresponding reordering of the columns). (auth)

2229 (BNL-18772) CRYSNET: A NETWORK OF INTELLIGENT REMOTE GRAPHICS TERMINALS. Bernstein, H. J.; Andrews, L. C.; Bernstein, F. C. (Brookhaven National Lab., Upton, N. Y. (USA)). 1973. 12p. (CONF-740512-6). Dep. NTIS $4.00.

From 2nd AEC scientific computer information exchange meeting; New York, New York, USA (2 May 1974).

2230 (CEA-CONF-2109) CONTROL OF SYSTEMS REGULATED BY PARTIAL DIFFERENTIAL EQUATIONS. Villeminot, M.; Zwingelstein, R. (Compagnie d'Etudes et de Realisations de Cybernetique Industrielle (CERCI), 75-Paris (France)). 9 Aug 1972. 18p. (In French). (CONF-7210103-1). Dep. NTIS (U. S. Sales Only) $3.00.

From international federation of automatic control symposium; Paris, France (17 Oct 1972).

2231 (COO-1469-238) QUARTERLY TECHNICAL PROGRESS REPORT, OCTOBER, NOVEMBER, DECEMBER 1973. (Illinois Univ., Urbana (USA). Dept. of Computer Science). 1973. 144p. (COO-2383-6; UIUCDCS-QPR-73-4). Dep. NTIS $10.25.

2232 (COO-2383-3) ICGS SYSTEM: USERS MANUAL. Mueller, D. H. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Feb 1974. Contract AT(11-1)-2383. 29p. (UIUCDCS-R-74-608). Dep. NTIS $4.50.

The Illinois Computing Graphics System (ICGS) is a batch system for a minicomputer. It executes a limited number of system programs, and provides facilities for rapid overlaying of these programs. This manual is intended to aid the user in preparing system modules and executing the system. (auth)

2233 (JINR-P10-7569) HILBERT INFORMATION FEATURES AND THEIR APPLICATION FOR PATTERN RECOGNITION. Soroko, L. M.; Strizh, T. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1974. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The Hilbert information features are introduced. Use of these features together with the Fourier information features increases the dimensionality of feature space formed by the optical cascades at the coherent lighting from 3 to 8. The values of the reference vector components for the information features in the six-dimensional space are presented for several letters of the Roman alphabet. (auth)

2234 (KAPL-P-4012) GRAIL: A GRAPHICAL DEVICE-INDEPENDENT PICTURE DESCRIPTION SYSTEM. Brooking, J. A. (Knolls Atomic Power Lab., Schenectady, N. Y. (USA)). 8 Feb 1974. Contract W-31-109-eng-52. 47p. Dep. NTIS $5.50.

2235 (KFK-1926) PREPARATION OF A PROGRAM SYSTEM WITH SPECIAL CONSIDERATION OF PORTABILITY PROPERTIES. Fichtel, H. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Datenverarbeitung in der Technik). Feb 1974. 49p. (In German). Dep. NTIS (US Sales Only) $5.50.

A general problem in the development of software for medium-sized and minicomputers is the problem of portability. Generally there are no standardized and compatible high-level programming languages for this class of computers. In a typical example, the development of portable software applying the concept of abstract machine modeling is described and evaluated. (tr-auth)

2236 (KFK-EXT-8-73-?) GRAPHIC REFERENCE MANUAL. Schnauder, H. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Reaktorentwicklung). Dec 1973. 116p. (In German). Dep. NTIS (U. S. Sales Only) $9.00.

The GRAPHIC Reference Manual describes syntax and semantics of the GRAPHIC language, which provides means for creating editing and output of graphical informations. It also describes the files and the Job Control Statement required for practical applications. (auth)

2237 (KFK-EXT-8-73-3) GRAPHIC: AN ICES SUBSYSTEM FOR GENERATING AND EDITING GRAPHICAL INFORMATION. Schuster, R.; Enderle, G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Reaktorentwicklung). Oct 1973. 32p. Dep. NTIS (U. S. Sales Only) $4.75.

With the aids of ICES a graphical system was implemented, which provides the user with means for input, manipulation and output of graphical information in 2 dimensions. (auth)

2238 (KFK-EXT-8-73-4) REGENT: FOURTH SEMIANNUAL PROGRESS REPORT, APRIL 1973 - OCTOBER 1973. Schlechtendahl, E. G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Reaktorentwicklung). Jan 1974. 36p. (In German). Dep. NTIS (U. S. Sales Only) $5.00.

The project REGENT (German acronym for CAD, Computer aided design) was started early 1972 by the Institut fuer Reaktorentwicklung. The fourth semiannual progress report summarizes the results achieved up to September 30, 1973, in particular with respect to the development of REGENT system nucleus. Details which have been documented in the references are not presented. The expected progress in the next half year period is listed. (auth)

2239 (KFK-EXT-13-73-2) SOME THOUGHTS ABOUT THE LAY OUT OF USER-OPERATING SYSTEM INTERFACES AS A BASIS FOR SYSTEM SOFTWARE STANDARDIZATION. Nehmer, J. (Kernforschungszentrum Karlsruhe (F. R. Germany). Inst. fuer Datenverarbeitung in der Technik). Dec 1973. 37p. (In German). Dep. NTIS (U. S. Sales Only) $5.00.

The problem of integrating user written software into existing operating systems is discussed. On the basis of Dijkstra's layer model, the dispatcher functions of the executive control are defined and semantically described. (auth)

2240 (KFK-PDV-12(Pt.2)) INTERACTIVE DIALOG SYSTEM. PART II. Kazis, E. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Oct 1973. 49p. (In German). Dep. NTIS (U. S. Sales Only) $5.50.

2241 (LA-5519-MS) FUNCTIONALS ADDITIVE ON A SYMMETRIC SET. Cashwell, E. D.; Everett, C. J. (Los Alamos Scientific Lab., N. Mex. (USA)). Mar 1974. Contract W-4705-eng-36. 4p. Dep. NTIS $4.00.

A Galois correspondence $S \rightarrow \tau S$, $T \rightarrow ST$ is set up between a lattice S of symmetric sets S of pairs (X,Y) of vectors of Hilbert space H, and a lattice τ of subspaces T of continuous functionals t on H, τS being the space of functionals additive on S, and ST the additivity domain of the space T. This viewpoint suggests many deep problems, some of which are discussed. Perhaps the most interesting is the characterization of those (momentum) probability densities consistent with the relativistic elastic collision relation. Some significant positive results are (1) the only pairs on which all functionals "through the origin" are additive satisfy $|X|\,|Y| = 0$; (2) the only pairs on which all homogeneous functionals are additive are collinear; (3) if t is a functional additive on all orthogonal pairs, and on all unidirectional pairs, or on all oppositely directed pairs, then t is linear. (auth)

2242 (LA-5534-MS) ALTERNATING-DIRECTION GALERKIN METHODS FOR PARABOLIC AND HYPERBOLIC PROBLEMS ON RECTANGULAR POLYGONS. Dendy, J. E. Jr.; Fairweather, G. (Los Alamos Scientific Lab., N. Mex. (USA)). Mar 1974. Contract W-7405-eng-36. 52p. Dep. NTIS $5.45.

Douglas and Dupont have formulated several alternating-direction Galerkin schemes on rectangular regions. It is shown that for certain time-dependent problems on rectangular polygons these schemes can be implemented with no more work than in the rectangular case; in fact the number of arithmetic operations required to complete one time step is O(N), where N is the number of unknowns at each time step. The results extend to systems of nonlinear parabolic equations and to problems on unions of rectangular parallelepipeds in R^3. (auth)

2243 (LA-UR-73-1287) SET THEORETIC APPROACH TO DATA TYPE EXTENSION. Morris, J. B.; Wells, M. B. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. 15p. (CONF-740309-2). Dep. NTIS $3.00.

From symposium on very high level languages; Santa Monica, California, USA (28 Mar 1974).

The approach to defining new data types in Madcap 6 is through set theory. Utilizing what amounts to a language within a language, one may construct, in theory, any subset of UNIVERSE (the set of all Madcap values) as the data type of a variable. The result of allowing such declarations allows a unified basis for a wide spectrum of "compiler directives." These compiler directives will allow the implementers of such a language to provide a great many tools which will enable a user to become a more effective programmer. These include: (1) range checking of variables; (2) bounds checking of subscripted variable references; (3) classical compile-time type checking; (4) effective generated-code improvement; (5) better documentation and clarity in programs. (auth)

2244 (RT/FI-(73)32) STATISTICAL ELABORATION OF EXPERIMENTAL RESULTS. I. Principles of Calculation of Probability. Oliva, P. R.; Terrasi, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Aug 1973. 112p. (In Italian). Dep. NTIS (U. S. Sales Only) $8.75.

The basis of the more advanced science of statistical inference is described. The theory of probability is presented in the classical way. (auth)

2245 (RT/FIMA-(73)2) GRAFD3: A SUBPROGRAM FOR THE THREE-DIMENSIONAL REPRESENTATION OF A SURFACE Z(x,y). Mengoli, P.; Taroni, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 27 Nov 1973. 30p. (In Italian). Dep. NTIS (U. S. Sales Only) $4.50.

A subroutine is presented for plotting a function of two independent variables, defined on a rectangle, as a three-dimensional figure. The subroutine is written in FORTRAN IV for the computer IBM 360/75 and the plotter Calcomp 915/1136 of the CEN Computer Center in Bologna, but it can be easily modified for use on other computers and plotters. (auth)

2246 (SGAE-2219) CAMAC: ANALOG MODULS. Marschik, W.; Schwabach, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronikinstitut). Dec 1973. 24p. (In German). Dep. NTIS (U. S. Sales Only) $4.25.

A 16-channel-analog-multiplexer with analog-to-digital-conversion and a digital-to-analog-converter with two independent channels (12 bit each) is described. (auth)

2247 (SGAE-2225) SPHERE SIZE METER IN THE CAMAC KDM-1. Buschbeck, F.; Telefont, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronikinstitut). Jan 1974. 18p. (In German). Dep. NTIS (U. S. Sales Only) $4.00.

The value of analogue pulses of different width should be digitized and should be sent to a computer via Camac-dataway to be processed. This module contains a sample-hold-amplifier to store the pulse peaks and an ADC. After the conversion a LAM signal is produced. (auth)

2248 (SGAE-2227) FORTRAN SUBROUTINE PAT. Decoding and Conversion of Paper Tapes in any Code. Horvath, F.; Krotz, W. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Jan 1974. 14p. (In German). Dep. NTIS (U. S. Sales Only) $4.00.

The FORTRAN subroutine PAT was written for a system IBM/360. It facilitates the input of 8 channel paper tapes in any code via IBM/2671 paper tape reader. When it has read a record, it transcribes the characters and forwards them to the calling program in one of the following modes: in form of integer numbers in 4 byte words; in form of floating point numbers in 4 byte words; in form of EBCDIC characters (for printout using A format). (auth)

2249 (SLA-74-95) BRIEF INSTRUCTIONS FOR USING THE SANDIA NUMERICAL MATHEMATICAL SUBROUTINE LIBRARY ON THE CDC 6600. Bailey, C. B.; Jones, R. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 110p. Dep. NTIS $8.50.

The Sandia Numerical Mathematical Subroutine Library (MATHLIB) consists of a number of dependable, high-quality, general-purpose mathematical computing routines. A brief description of how to select and use each routine in the library is provided. (auth)

2250 (SLA-74-141) MATHEMATICAL MODEL FOR DETERMINING THE PROBABILITY OF VISUAL ACQUISITION OF GROUND TARGETS BY OBSERVERS IN LOW-LEVEL HIGH-SPEED AIRCRAFT. Bradford, W. H. (Sandia Labs., Albuquer-

que, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 22p. Dep. NTIS $4.25.

A cumulative distribution function for determining the probability of visually acquiring ground targets by observers in low-level high-speed aircraft has been formulated as a function of range from target and a number of other parameters believed to have a major influence on target acquisition. Some illustrative calculations are included. (auth)

2251 (SLA-74-198) GLOBAL ERROR ESTIMATION FOR ORDINARY DIFFERENTIAL EQUATIONS. Shampine, L. F.; Watts, H. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974. 30p. (CONF-740511-2). Dep. NTIS $4.50.

From Mathematical Software II conference; Lafayette, Indiana, USA (29 May 1974).

2252 (SLA-74-5065) COMPUTER GENERATED VISUAL DOCUMENTATION OF THEORETICAL STORE SEPARATION ANALYSES. Spahr, H. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974. 26p. (CONF-740512-5). Dep. NTIS $4.50.

From second AEC scientific computer information exchange meeting; New York, New York, USA (2 May 1974).

A computer code was developed that computes the theoretical trajectory of a store (i.e., bomb, fuel tank, etc.) in the complex aircraft flow field after it is released from an aircraft flying at subsonic speeds. The problem remained of documenting the results of the store separation analysis in a concise, clear manner. A visual documentation system being used by Sandia Laboratories to document the results of theoretical store separation analyses is described. The documentation system uses a new Sandia Laboratories computer program, MOVIE1, with a CDC 6600 computer to generate a magnetic tape of plotting commands for a DatagraphiX 4020 plotter. Techniques are discussed that reduce the computer time required for one theoretical store separation to a few seconds to generate a magnetic tape for drawings and to a few minutes to generate the magnetic tape for movies. (auth)

2253 (SLA-74-5186) REAL TIME DIGITAL CONTROL OF REMOTE TRACKING INSTRUMENTS. Anderson, D. F.; Maschoff, L. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). [nd]. 22p. Dep. NTIS $4.25.

A technique is described for providing real time spherical coordinate tracking data to remote manned tracking instruments. Updates are provided at a rate of 10 per second. Input data are from tracking radars. Within the same real time frame, radar target position is plotted for test controller displays. Radio transmission of data, input/output interface units, data processors, and the central computer facility are described. (auth)

2254 (SLL-73-215) CDC 6600 DATA MANAGER. A Multi-dimensional Tabulated Function Manager and Linear Interpolator. Mansfield, J. (Sandia Labs., Livermore, Calif. (USA)). Apr 1974. Contract AT(29-1)-789. 30p. Dep. NTIS $4.50.

The Data Manager package provides minimum field length storage allocation and organization for multi-dimensional tabulated functions and performs linear interpolation from them. Function entries are vectors of length one or more. There is no limit in theory to the maximum dimensionality, i.e., number of independent variables, of a table. Function storage may be allocated to extended core or central memory at the user's option. A choice of binary or linear searching algorithms is provided to minimize searching time during interpolation for discontinuous or continuous independent variables. (auth)

2255 (SLL-73-305) TJMAR1: FORTRAN SUBROUTINE FOR NONLINEAR LEAST SQUARES PARAMETER ESTIMATION. Jefferson, T. H. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 29p. Dep. NTIS $4.50.

TJMAR1 is a CDC 6600 Fortran subroutine designed for nonlinear least squares parameter estimation. The principal applications of the routine are in data fitting and in solving systems of simultaneous algebraic equations. This document is a user's manual for TJMAR1 and contains a description of the mathematical method employed, an explanation of the calling sequence, and examples of use. (auth)

2256 (SLL-74-5218) GRAPHICS APPLICATIONS FOR FINITE ELEMENT CODE PROCESSING. Gabrielson, V. K. (Sandia Labs., Livermore, Calif. (USA)). Apr 1974. 20p. (CONF-740512-4). Dep. NTIS $4.00.

From second AEC scientific computer information exchange meeting; New York, New York, USA (2 May 1974).

The application of interactive graphics to mesh generation and to output display processing of finite element codes is described. (auth)

2257 (UCID-16171) USERS MANUAL FOR CODE EPSOL. Static Analysis of Elastic–Plastic Solids. Hartzman, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Nov 1972. Contract W-7405-eng-48. 8p. Dep. NTIS $4.00.

2258 (UCID-16462) LECTURE NOTES FOR A COURSE IN THE FUNDAMENTALS OF DIGITAL SYSTEMS. Fisher, D. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Win 1974. Contract W-7405-eng-48. 189p. Dep. NTIS $12.50.

The course begins with the basic concepts of the switching element and develops from that the principles involved in the design of complex logic systems. This leads to the ultimate digital system, the computer. Both the hardware and software aspects of computer technology are covered. (MOW)

2259 (UCID-30045) SOLUTION OF BANDED LINEAR SYSTEMS. Hindmarsh, A. C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 May 1972. Contract W-7405-eng-48. 37p. Dep. NTIS $5.00.

Four subroutine packages are described, each of which carries out the direct solution of a system of linear equations for which the coefficient matrix is real and banded along the main diagonal. In each, the method of LU decomposition (without pivoting) is applied to the matrix; the solution is then obtained by back-substitution in a separate routine. The general case and the symmetric case are treated separately. For each of these, the case where the matrix resides entirely within core and the case where it does not are treated separately. (auth)

2260 (UCID-30090) METRIC: A UNIT-CONVERSION PROGRAM FOR THE CDC 7600. Part 1. Using the Program. Lai, D. Y. F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Mar 1974. Contract W-7405-eng-48. 26p. Dep. NTIS $4.50.

METRIC converts quantities expressed in one set of units into their equivalents in a second set of units. Basically, it is designed to convert quantities to the SI metric system, but the user can specify the second set of units if he chooses. Among METRIC's additional features are simplified repetitive conversion and provision for the user to define "temporary units" as intermediates in conversions. METRIC is available as an executable public file on the CDC 7600 computers in the Livermore time-sharing system. (auth)

2261 (UCRL-75578) SET OF DEVICE-INDEPENDENT FIRST LEVEL GRAPHICS ROUTINES. Storch, N. A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Mar 1974. 10p. (CONF-740512-3). Dep. NTIS $4.00.

From second AEC scientific computer information exchange meeting; New York, New York, USA (2 May 1974).

A set of graphics routines (TV80) used as a language to plot points, lines and characters by Fortran applications programs is described. It is a device-independent version of a set of routines long used at Lawrence Livermore Laboratory. Whereas the old routines were limited to one device, TV80 allows access to a number of devices through independent software processors. Features include scaling, clipping, scan conversion and character generation for raster devices, identification of output, handling of on-line display hardware, and generation of display commands. (auth)

Miscellaneous

2262 (HU-TFT-73-34) RECOIL EFFECTS IN QUANTUM ELECTRONICS: THE NONLINEAR MOLECULAR RESPONSE. Stenholm, S. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Dec 1973. 51p. Dep. NTIS (U. S. Sales Only) $5.75.

The equations of motion for the density matrix of a two-level molecule interacting with two oppositely propagating semiclassical waves are derived. The equations are shown to correctly reproduce earlier results by Kol'chenko, Rautian and Sokolovskii for one travelling wave, and their perturbation treatment for a standing wave. The saturated absorber experiment is treated, in the case when one travelling wave is weak enough to allow a perturbation expansion in its amplitude. The velocity dependent absorption function is investigated in detail, and the effect of recoil on the the processes: Raman scattering, Rayleigh scattering and dynamic Stark splitting is obtained and discussed. These were treated without recoil by Haroche and Hartmann and a detailed comparison with their work is included. Finally there is a brief discussion of the importance of recoil for different situations in quantum electronics. (auth)

2263 (INP-858) CALCULATIONS OF EFG AND PAC ATTENUATION FROM RANDOMLY DISTRIBUTED SOLUTES IN CUBIC LATTICES. Kajfosz, J. (Institute of Nuclear Physics, Krakow (Poland)). 1973. 38p. Dep. NTIS (U. S. Sales Only) $5.00.

The distributions of electric field gradients of different origin

as well as the corresponding attenuation of the perturbed angular correlation from solute atoms randomly distributed in a cubic host lattice were studied by Monte Carlo simulation. A description of the procedure is presented and some general properties of these effects from the point of view of the interpretation of experimental results are discussed. (auth)

2264 (ITF-73-144-P) DIAGRAM TECHNIQUE FOR DEFINING THE COMPLETE CORRELATION FUNCTION. Olekseeva, M. F.; Tovstyuk, K. D. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1973. 35p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.75.

To build approximating the Hamiltonian and to calculate the complete correlation function, a new technique based on the symmetric group theory is developed. (auth)

2265 (ITF-73-168-P) SELF-CONSISTENT FIELD APPROXIMATION IN DE GENNES MODEL. Levitskii, R. R.; Stasyuk, I. V. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1973. 22p. (In Russian). Dep. NTIS (U. S. Sales Only) $4.25.

The proton system behavior of ferroelectrics with hydrogen bonds described by a model hamiltonian is considered. Using the spin-operator diagram techniques, the correlation functions are calculated in a higher order of the reciprocal interaction radius as compared with chaotic phase approximation. The self-consistent equation for spontaneous dipole momentum is obtained. The polarization waves and their damping are considered. These results are compared with experimental data. (auth)

2266 (LA-UR-73-1297) SITUATION IN WHICH THE ESTIMATION OF THE "INTERACTION VARIANCE" IS THE PURPOSE OF AN EXPERIMENT. Moore, R. H.; Tietjen, G. L.; Ramsey, J. B. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. Contract W-7405-eng-36. 9p. (CONF-740506-1). Dep. NTIS $4.00.

From 28th annual technical conference of the American Society for Quality Control; Boston, Massachusetts, USA (20 May 1974).

In most discussions of multi-way, random-effects analysis of variance models, symbols and techniques for estimating the interaction variances are introduced. However, these interaction variances seldom are meaningfully described or justified in the accompanying discussion. A situation is described in which the primary experimental interest is the estimation of the interaction variance of a two-way, mixed-effects model. This variance is important because it can be used in production control to distinguish "good" lots of exploding-wire detonators from "bad" lots. (auth)

2267 (NP-19970) SEVENTH GENERAL REPORT ON THE ACTIVITIES OF THE EUROPEAN COMMUNITIES IN 1973. (Commission of the European Communities, Brussels (Belgium); Commission of the European Communities, Luxembourg). Feb 1974. 547p.

In 1973, the enlarged Community was disrupted by the growing impact of external upheavals on its functioning. There were the successive monetary crises, the rise in commodity prices, the soya alert of spring 1973, and the events in the Middle East and the accompanying oil crises. The plea is issued for joint reaction in the face of these new challenges. The activities of the Communities in 1973 are discussed in seven chapters: The enlargement of the Communities; Development of the institutions; The composition and functioning of the institutions; The functioning of the common market; The development of common policies within the Communities; External relations; and Community law. Memoranda annexed to the address on the program for 1974 and additional information are included on each chapter. (auth)

2268 (TID-26544) SPECTRA OF ATMOSPHERIC MOTIONS IN THE UPPER-TROPOSPHERE AND LOWER-STRATOSPHERE OVER NORTH AMERICA AND AUSTRALIA: EXPERIMENTAL RESULTS AND THEORETICAL CONSIDERATIONS. Atmospheric Science Paper No. 211. Abbey, R. F. Jr. (Colorado State Univ., Fort Collins (USA). Dept. of Atmospheric Science). Jul 1972. 144p. Dep. NTIS $10.25.

Spectrum analysis of the 200- and 300-mb wind components for 127 North American stations and of the 30-, 35-, and 40,000 ft-level winds for 10 Australian stations reveal distinct geographical variations of spectral densities at particular frequencies. Maximum spectral energies occur at periodicities 4.9- and 3.4-days that are representative of the time-scale for synoptic disturbances. Generally, the meridional spectral values exceed the zonal ones. The strong horizontal gradients of the kinetic energy spectra in frequency space determined in this study suggest that a regional treatment of the multivariate kinetic energy equation will have to contend with a careful evaluation of boundary flux terms. (MCW)

Chemistry

2269 (AERE-M-2519) REVERSE OSMOSIS MEMBRANES CAST FROM A CELLULOSE ACETATE–METHANOL–DIOXAN DOPE. Warren, D. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jan 1974. 23p. Dep. NTIS (U. S. Sales Only) $3.25. UK 50 pence.

The feasibility of preparing satisfactory reverse osmosis membranes from a methanol/dioxan solution was investigated, and the results obtained by varying evaporation conditions and curing temperatures were analyzed in order to determine the optimum conditions. Suggestions are offered to account for the poor reproducibility of membrane performance, and to improve it. (auth)

2270 (AERE-R-7615) 365 nm PHOTOLYSIS OF NITROUS ACID VAPOR IN AIR. Atkins, D. H. F.; Cox, R. A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Dec 1973. 32p. Dep. NTIS (U. S. Sales Only) $3.75. UK £1.00.

Mixtures containing low concentrations of nitrous acid vapor in air have been produced from dilute solutions of acidified sodium nitrite. The vapor concentrations of HNO_2 obtained were far higher than expected on the basis of the gas phase equilibrium $2\,HNO_2 \rightleftharpoons NO + NO_2 + H_2O$ that confirms the unexpected stability of nitrous acid vapor reported. A method was devised for the semi-continuous measurement of HNO_2, NO, and NO_2 concentrations in air using a commercial chemiluminescence nitric oxide analyzer. The analytical system has facilitated, for the first time, a systematic study of the photolysis of nitrous acid vapor in its first absorption band at 365 nm. The products of the photolysis of nitrous acid vapor in air are nitric oxide, nitrogen dioxide, and nitric acid. From a study of the rates of product formation as a function of the initial concentrations of HNO_2, NO, and NO_2 it appears that the primary yield, based on estimates of the extinction coefficient for HNO_2 at 365 nm, is close to unity. (auth)

2271 (ANCR-1133) X-RAY: AN ON-LINE PROGRAM FOR AUTOMATIC ELECTRON MICROANALYSIS OF OXIDES AND SILICATES USING A Si(Li) SPECTROMETER. Gehrke, R. J.; Davies, R. C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Mar 1974. Contract AT(10-1)-1375. 89p. Dep. NTIS $5.45.

X-RAY is an on-line, FORTRAN program for the automatic electron microanalysis of silicates and oxides. It is written for a PDP-11 computer having 12K of core in addition to disc, drum or magnetic tape storage. Energy dispersive x-ray data are acquired with a Si(Li) spectrometer mounted on a scanning electron microscope (SEM) or an electron microprobe. The data are transferred from the acquisition instrument through an interface to the PDP-11 computer for on-line processing or are stored on paper tape or magnetic tape for later batch processing. X-RAY automatically locates the x-ray peaks in a spectrum, determines the elements associated with the x-ray peaks and calculates their relative abundances through a least-squares fit of the spectrum with spectra of element oxide standards (i.e., components). In this application of least-squares fitting, the component spectra are obtained from the electron excitation of simple oxide standards whenever possible or from multi-element oxide or silicate standards. The contributions of each component spectrum are expressed as ratios of composite to component spectrum. Finally, the ratios are corrected for matrix effects to yield the percent concentration of each element oxide in the sample. The appendices include a descriptive program handbook for the user, a list of the program commands with their functions, the link modules, the format requirements for data to be input to the computer, a detailed flow chart of the program and a complete program listing. (auth)

2272 (BNL-tr-539) INVESTIGATION OF THERMAL DECOMPOSITION OF AMMONIUM HALATES. Boldyrev, V. V.; Banshagi, T.; Korobeinichev, O. P.; Savintsev, Yu. P.; Mulina, T. V.; Karpenko, Yu. Ya.; Shoimoshi, F. Translated by S. J. Amoretty from Kinet. Katal.; 13: No. 1, 80-85(1972). 15p. Dep. NTIS $3.00.

The products of the initial stages of thermal decomposition of ammonium halates were analyzed and the surface of the decomposing halate crystals were observed. The influence of various additives on the rate of thermal decomposition of ammonium halates was studied. These additives are known to have a profound effect on the thermal decomposition of ammonium perchlorate. (MCW)

2273 (CEA-CONF-2534) CHEMICAL VAPOR DEPOSITION AT LOW TEMPERATURES. Viguie, J. C.; Spitz, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Metallurgie). 18 Jun 1973. 12p. (CONF-731066-1). Dep. NTIS (U. S. Sales Only) $3.00.

From 144th national meeting of the Electrochemical Society and 2nd international symposium on fine particles; Boston, Massachusetts, USA (7 Oct 1973).

CVD at atmospheric pressure and using temperatures not higher than 500°C has industrial importance. Oxides and metals were obtained from acetylacetonates. The best way of transporting the materials is to dissolve the chelate in a solvent and blow aerosol

of the solution towards the heated substrate. A difference is made between splashing and growth by means of genuine vapor deposition. In the latter case, layers whose thickness lies between 500 and 5000 Å produce the same optical quality as those obtained by vacuum techniques. An example is presented in the case of deposition of ferric oxide on glass substrates. (auth)

2274 (CONF-740111-1) IONIZATION POTENTIALS OF ARYL SUBSTITUTED N-t-BUTYL BENZAMIDES. Block, A. McB.; Tsai, R.; Rubottom, G. M. (Puerto Rico Nuclear Center, Rio Piedras). 1973. 4p. Dep. NTIS $3.00.

From fourth conference on structure-energy relationships; San Juan, Puerto Rico (9 Jan 1974).

2275 (COO-2092-29) CROSSED MOLECULAR BEAM STUDIES AND DYNAMICS OF DECOMPOSITION OF CHEMICALLY ACTIVATED RADICALS. Lee, Y. T. (Chicago Univ., Ill. (USA)). 1973. 13p. (CONF-730987-1). Dep. NTIS $3.00.

From eleventh international symposium on free radicals, Munich, West Germany, 4 Sep 1973, 8 Sep 1973.

2276 (COO-2249-3) TRANSPORT PROCESSES AND TRACE CONSTITUENTS IN THE STRATOSPHERE. Annual Progress Report. Cunnold, D. M. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Meteorology). 15 Mar 1974. Contract AT(11-1)-2249. 91p. Dep. NTIS $7.75.

Progress in three areas is reported: numerical modeling, stratospheric data analysis, and the effects of trace constituents on heating rates. A general circulation model being developed with the ultimate objective of assessing the effect of SST operations on the atmospheric ozone distribution is reported. The model variables are represented in the spectral domain using 79 spherical harmonics and 26 vertical levels between the ground and 70 km. The results of a three year integration (run 12) to simulate the unperturbed global ozone distribution are presented. The model shows the presence of a westerly stratospheric jet in the winter hemisphere with amplitude similar to those observed in the polar night jet; easterlies dominate in the summer hemisphere. The model also shows ozone to be transported polewards and downwards. The annual cycle in ozone concentrations at midlatitudes was simulated. Preliminary comparisons were made with other features of the dynamics and ozone distribution in the stratosphere. The contribution of particulates resulting from SST operations to heating in the stratosphere was calculated and found to be considerably smaller than the heating due to the ambient gases of the stratosphere. Two types of aerosols were considered, the particle consisting largely of sulfuric acid that is formed from SST SO_2 emissions, and SST soot. When a representative value of 0.01 is assumed for the absorptive index of sulfate particles, the SST sulfate aerosol heating at 15 km is approximately 0.05°K/day. (JGB)

2277 (EUR-5052) CALCULATED DISTRIBUTION OF THE CHEMICAL SPECIES OF COPPER, ZINC, CADMIUM, AND LEAD IN 16 LAKES OF NORTHERN ITALY. Baudouin, M. F.; Scoppa, P. (Commission of the European Communities, Luxembourg; Commission of the European Communities, Ispra (Italy). Joint Nuclear Research Center). Feb 1974. 88p. Dep. NTIS (U. S. Sales Only) $6.50.

A pH-dependent model developed for seawater has been adapted to the speciation of Cu, Zn, Cd, and Pb in freshwaters. The model was used to calculate the degree of interaction between each of the metal ions and the anions Cl^-, $SO_4^=$, HCO_3^-, $CO_3^=$ and OH^-, as a function of pH to sixteen lakes of Northern Italy. The calculations showed that the metals examined can be complexed to a considerable extent and that the distribution of the chemical species of the metals varies greatly with changes of pH and water composition. (auth)

2278 (INP-847) ABSORPTION SPECTRA OF P-METHOXY BENZYLIDENE p-n-BUTYLANILINE IN 80 TO 400 cm^{-1} RANGE AT TEMPERATURES BETWEEN −200 AND +70°C. Sciesinska, E.; Sciesinski, J.; Twardowski, J.; Janik, J. A. (Institute of Nuclear Physics, Krakow (Poland)). Sep 1973. 24p. Dep. NTIS (U. S. Sales Only) $4.25.

The absorption coefficient of all phases of p-methoxy benzylidene p-n-butylaniline was measured in the 80 to 400 cm^{-1} range. An analysis shows evidence that there are two modifications (metastable and stable) in the solid phase featuring different absorption spectra. (auth)

2279 (IS-M-14) ANALYTICAL METHODS FOR CHARACTERIZATION OF FLY ASH. Cavin, D. C.; Klemm, W. A.; Burnet, G. (Ames Lab., Iowa (USA)). [nd]. 21p. Dep. NTIS $4.25.

A typical power plant fly ash was characterized according to its composition and physical properties as a basis for research on iron and aluminum recovery from the ash. The methods used are standard and require facilities and instruments available in many laboratories today. The procedures include photomicroscopic observation, size separation, magnetic separation, X-ray diffraction, thermal gravimetric analysis, differential thermal analysis, electron microprobe analysis and emission spectroscopy. The results will be useful in determining in what ways and under what conditions a given fly ash may be treated to recover the metals present in a usable form. Preliminary work has been done on a sulfuric acid leaching process and on a lime sintering process patterned after exploratory studies reported from Poland in 1973. (auth)

2280 (IS-T-611) STUDY OF IRON AND ALUMINUM RECOVERY FROM POWER PLANT FLY ASH. Cavin, D. C. (Ames Lab., Iowa (USA)). Apr 1974. Contract W-7405-eng-82. 121p. Dep. NTIS $9.25.

Thesis.

A study of iron and aluminum recovery from power plant fly ash was undertaken in order to characterize a particular fly ash as a potential source of iron and aluminum. Magnetic separation of the iron-rich particles provided a fly ash fraction amenable to further iron extraction processes. Sulfuric acid leaching of the whole sample of fly ash as well as the fines (-200 mesh) showed a decrease in aluminum extractability at increasing acid strengths. Lime sintering of the nonmagnetic fines revealed an increase in aluminum extractability at higher mole ratios of CaO/Al_2O_3. (auth)

2281 (IS-T-629) BONDING AND PHASE TRANSITION IN (Ti,V)S SOLID SOLUTIONS. Leebrick, D. H. (Ames Lab., Iowa (USA)). Mar 1974. Contract W-7405-eng-82. 75p. Dep. NTIS $6.75.

Thesis.

The lattice parameters, density, and composition of samples in the (Ti,V)S system were determined, and percentage occupancies, valence electron concentrations, and unit cell volumes are derived. Group theory was used to show that the symmetry requirements for a second-order phase transition are satisfied for a MnP-to-NiAs phase transition. It was shown that to within the limits of experimental detectability, the physical requirements for a second-order phase transition are also met by this system. A likely explanation for the transition is proposed in terms of valence electron concentrations and band theory. (auth)

2282 (MHSMP-73-29) DISPOSAL OF WASTE OR EXCESS HIGH EXPLOSIVES. Progress Report, April–June 1973. Honea, F. I.; Bullerdiek, W. A.; Wichmann, J. E.; Mehrhoff, T. K. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1973. Contract DA-11-173-AMC-487(A). 32p. Dep. NTIS $4.75.

2283 (MHSMP-73-40) DISPOSAL OF WASTE OR EXCESS HIGH EXPLOSIVES. Progress Report, July–September 1973. Honea, F. I.; Bullerdiek, W. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1973. Contract DA-11-173-AMC-487(A). 20p. Dep. NTIS $4.00.

2284 (MHSMP-74-2) DISPOSAL OF WASTE OR EXCESS HIGH EXPLOSIVES. Progress Report, October–December 1973. Honea, F. I.; Mehrhoff, T. K. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1973. Contract DA-11-173-AMC-487(A). 67p. Dep. NTIS $6.50.

2285 (ORNL-tr-2655) CHEMISTRY OF COMPLEXES OF THE METHYLMERCURY CATION. Schwarzenbach, G.; Schellenberg, M. Translated by R. G. Mansfield from Helv. Chim. Acta; 48: No. 1, 28-46(1965). 29p. Dep. NTIS $4.50.

The stability constants of the methylmercury complexes $CH_3HgL^{1-\lambda}$ with a considerable number of ligands $L^{\lambda-}$ have been determined. Like H^+, the cation CH_3Hg^+ reveals the coordination number 1 almost exclusively. Some ligands form also binuclear adducts $(CH_3Hg)_2L^{2-\lambda}$ and sulfide even forms $(CH_3Hg)_3S^+$. The coordination behavior of CH_3Hg^+ and H^+ however are very different concerning the selection of ligands, the former being a soft and the latter a hard acid. The entropy ΔS of the reaction: $H^+ + L^- \rightarrow HL$ is more positive by about 14 e.u. than ΔS of the reaction: $CH_3Hg^+ + L^- \rightarrow CH_3HgL$. The hydrogen ion in aqueous solution has a far greater order producing action on the solvent than CH_3Hg^+. Two dyes also have been investigated, which may serve as indicators for CH_3Hg^+ and for the determination of pCH_3Hg (= $-\log [CH_3Hg^+]$). (auth)

2286 (ORNL-tr-2759) ASH ELEMENT CONTENT OF THE LITTORAL AND WATER PLANTS OF THE GOR'KOV STORAGE RESERVOIR. Dovbnya, I. V. Translated by M. Gerrard from Biol. Vnutr. Vod, Inform. Byull.; No. 15, 13-16(1972). 4p. Dep. NTIS $3.00.

Analyses were made of 60 samples of 22 species of plants that consisted largely of the higher water plants of the Gor'kov reservoir. The ash was determined in these plants and the percentage of organic materials in them was calculated together with the Na and K content of the ash. The plant material was calcined by the dry method in a muffle furnace at 400 to 450°C. The Na and K content of the ash was determined by flame photometry. (MCW)

2287 (SLA-73-1094) ORGANIC HYDROGEN GETTERS. Part II. Preparation and Properties of Phenyl Propargyl Ether and 1,6-Diphenoxy-2,4-Hexadiyne (DPPE). Courtney, R. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1974. Contract AT(29-1)-789. 13p. Dep. NTIS $4.00.

Phenyl propargyl ether has been prepared via a Williamson reaction between potassium phenoxide and propargyl chloride. The product, a colorless liquid, was used to prepare 1,6-diphenoxy-2,4-hexadiyne (DPPE) by oxidative coupling in pyridine with a copper (I) chloride catalyst. The DPPE is a white crystalline powder melting at 80°C. Both products' structures were verified by their Raman and infrared spectra. Thermal stability of DPPE was examined with differential scanning calorimetry and thermogravimetric analysis. (auth)

2288 (SLA-73-1099) QUANTITATIVE ANALYSIS OF THE INFLUENCE OF CONTAMINANTS ON THERMOCOMPRESSION BONDING OF GOLD. Holloway, P. H. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 27p. Dep. NTIS $3.50.

Surface chemical analyses by Auger electron spectroscopy (AES) indicate that oxide films and hydrocarbon residues are the most frequent contaminants on gold hybrid microcircuit metallization. AES data in conjunction with lead frame bonding data demonstrate that 5 Å of chromium oxide can degrade thermocompression bond strengths. The primary electron beam for AES cracks the hydrocarbon contaminants causing a carbonaceous residue. Lead frame bonding data demonstrated that a 10 Å thick carbon residue was indicative of thermocompression bond degradation. (auth)

2289 (UR-3490-392) ISOLATION OF A SODIUM-SPECIFIC IONOPHORE FROM ($Na^+ + K^+$)-ATPASE PREPARATIONS. Shamoo, A. E. (Rochester Univ., N. Y. (USA). Dept. of Radiation Biology and Biophysics). 1973. 39p. (CONF-731137-1). Dep. NTIS $4.00.

From international conference on the properties and functions of Na^+K^+-AtPase; New York, New York, USA (28 Nov 1973).

Life Sciences

2290 (AICS-4) WATER UTILIZATION AND AGRICULTURAL DEVELOPMENT IN WESTERN UTTAR PRADESH (A STUDY OF PROBLEMS INVOLVED IN TUBEWELL IRRIGATION FOR HIGH CROPPING INTENSITY). Gupta, V. K.; George, P. S.; Gaikwad, V. R. (Atomic Energy Commission, Bombay (India). Agro-Industrial Complex Working Group). 1971. 277p. Dep. NTIS (U. S. Sales Only) $17.00.

2291 (BNWL-1818) TOXICOLOGY OF INHALED LOW-FIRED AND HIGH-FIRED BERYLLIUM OXIDES IN THE RAT AND HAMSTER. Sanders, C. L.; Cannon, W. C.; Powers, G. J.; Adee, R. R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1974. Contract AT(45-1)-1830. 25p. Dep. NTIS $4.25.

Seventy rats and 70 hamsters were exposed to aerosols of high-fired BeO for 3 hours and examined at intervals for 63 days after exposure. The BeO exhibited an MMAD of about 1 μm. From 77 to 85% of the BeO was deposited in the tracheobronchial tree and 15 to 23% in the alveolar region, amounting to 150 μg of Be in rats and 20 μg Be in the alveoli of hamsters. Pathological alterations were limited primarily to the alveolar macrophage that rapidly concentrated BeO particles following exposure. The BeO was very insoluble as seen by lack of translocation of Be to liver and bone and the small amount excreted in urine. The BeO particles were tenaciously retained in alveolar macrophages with only 12 to 21% of alveolar-deposited BeO being cleared from the alveoli in 63 days. No significant differences were noted between sexes or between rat and hamster. (auth)

2292 (CEA-CONF-2545) PROTECTION PROBLEMS CAUSED BY NONIONIZING RADIATION. Jammet, H. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). 1973. 25p. (In French). (CONF-730907-22). Dep. NTIS (U. S. Sales Only) $3.25.

From third international congress of the International Radiation Protection Association meeting; Washington, District of Columbia, USA (9 Sep 1973).

2293 (CONF-731141-1) PROPOSED MECHANISMS BY WHICH AUTOCHTHONOUS NEOPLASMS ESCAPE IMMUNE REJECTION. Coggin, J. H. Jr.; Ambrose, K. R.; Dierlam, P. J.; Anderson, N. G. (Tennessee Univ., Knoxville (USA). Dept. of Microbiology; Oak Ridge National Lab., Tenn. (USA)). 1973. 42p. Dep. NTIS $4.25.

From third conference on embryonic and fetal antigens in cancer; Knoxville, Tennessee, USA (4 Nov 1973).

2294 (CONF-740505-1) BACKGROUND CONCENTRATIONS OF MERCURY AND METHYLMERCURY IN UNPOLLUTED FRESHWATER ENVIRONMENTS. Huckabee, J. W.; Hildebrand, S. G. (Oak Ridge National Lab., Tenn. (USA)). 1973. 14p. Dep. NTIS $3.00.

From first international mercury congress conference; Barcelona, Spain (6 May 1974).

2295 (COO-1300-35) ORGANIZATION OF THE R CHROMOSOME REGION IN MAIZE. Annual Report of Research. Kermicle, J. L. (Wisconsin Univ., Madison (USA)). Jan 1973. Contract AT(11-1)-1300. 11p. Dep. NTIS $4.00.

2296 (COO-3276-12(74)) ULTRAVIOLET IRRADIATION OF NUCLEIC ACIDS AND RELATED COMPOUNDS. Progress Report, July 1, 1973–June 30, 1974. Wang, S. Y. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Biochemistry). 1974. Contract AT(11-1)-3276. 8p. Dep. NTIS $4.00.

2297 (COO-3277-28) ORIGIN OF BIOLUMINESCENCE AND THE OXYGENATION OF POLYNUCLEAR AROMATIC HYDROCARBONS. Seliger, H. H. (Johns Hopkins Univ., Baltimore, Md. (USA)). 1974. Contract AT(11-1)-3277. 18p. Dep. NTIS $4.00.

2298 (IJS-R-616) THERMODYNAMICAL STUDIES OF COOPERATIVE OXYGEN BINDING BY HEMOGLOBIN. Svetina, S. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Sep 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

2299 (ORO-2687-26) RESEARCH IN PHOTOSYNTHESIS. Final Report, March 1, 1960–September 30, 1972. Gaffron, H. (Florida State Univ., Tallahassee (USA). Inst. of Molecular Biophysics). 1972. Contract AT(40-1)-1687. 21p. Dep. NTIS $4.25.

2300 (ORO-4056-4) PROGRESS REPORT ON INTRACELLULAR TRANSPORT OF IONS IN MINERALIZING TISSUES, JULY 1, 1972–MARCH 20, 1974. (Baylor Univ., Dallas, Tex. (USA). Coll. of Dentistry). 1974. Contract AT(40-1)-4056. 5p. Dep. NTIS $4.00.

2301 (ORO-4182-4) DIFFERENTIAL GENE EXPRESSION IN NEUROSPORA CRASSA CELL TYPES. Progress Report, February 1, 1973–March 31, 1974. Dutta, S. K. (Howard Univ., Washington, D. C. (USA)). 1974. Contract AT(40-1)-4182. 30p. Dep. NTIS $4.50.

2302 (ORO-4257-2) CHEST FLUOROSCOPY AND NEOPLASIA IN TUBERCULOSIS PATIENTS: A RETROSPECTIVE SURVEY. (North Carolina Univ., Chapel Hill (USA). School of Medicine). 1974. 17p. Dep. NTIS $4.00.

The incidence of neoplasia in a population of tuberculosis patients repeatedly exposed to x-ray was investigated. The study population includes approximately 4700 patients, treated with artificial pneumothorax and/or pneumoperitoneum therapy (collapse treatment) requiring numerous chest fluoroscopies. It is thought that a retrospective survey will provide information on the morbidity and mortality rates for skin, breast, lung, mouth, pharynx, larynx, esophagus, stomach, and thyroid cancers, and leukemia. The experience of this group is being compared to that of a matched control group. (auth)

2303 (SGAE-2221) INFLUENCE OF PREDNISOLONEACETATE ON THE DNA SYNTHESIS OF CELLS OF SYNOVIAL FLUID IN PATIENTS WITH CHRONIC POLYARTHRITIS. Klein, G.; Altmann, H.; Eberl, R.; Broell, H.; Wottawa, A. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Inst. fuer Biologie). Dec 1973. 14p. (In German). Dep. NTIS (U. S. Sales Only) $4.00.

2304 (TID-26560) CELL RESPONSE TO NUCLEIC ACID PENETRATION. Progress Report, July 1, 1973–March 15, 1974. Stuy, J. H. (Florida State Univ., Tallahassee (USA)). 1974. Contract AT(40-1)-3885. 27p. Dep. NTIS $4.50.

Of every ten adsorbed phage HP1 DNA molecules, lysogenic Haemophilus influenzae integrates about one molecule in the resident prophage, leaves one to two molecules unintegrated but undamaged, completely depolymerizes extracellularly two to three molecules and intracellularly destroys four to six molecules. Integration involves whole molecules; gene conversion must then subsequently occur. The extracellular breakdown process does not appear related to integration; enzymes involved may be exonucleases III and I. Intracellular degradation products include single strands. Transfecting adsorbed phage HP1 DNA in non-lysogens undergoes the same degradation processes but it is not integrated. A minute fraction appears to be fused into covalently closed circles upon adsorption; these forms are the first intermediates in the transfection process. Circular DNA forms seem to be adsorbed normally. They may be sheared to linear forms upon attachment, however. This may explain their subsequent depolymerization. Foreign DNA are depoly-

merized at a much lower rate. This is not understood. Phage restriction enzyme(s) affect transfection to the same extent as it restricts phage but it has no influence on transformation. (auth)

2305 (UCB-34-P-156-X-6) COMPREHENSIVE PROGRESS REPORT, FEBRUARY 1, 1971–JUNE 30, 1974. Ames, B. N. (California Univ., Berkeley (USA). Dept. of Biochemistry). 1974. Contract AT(04-3)-34. 21p. Dep. NTIS $4.25.

2306 (UCRL-75520) SCANNING CYTOPHOTOMETRY: PRINCIPLES AND PRACTICE. Mayall, B. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Mar 1974. 16p. (CONF-731007-7). Dep. NTIS $4.00.

From first symposium on mammalian cells: probes and problems; Los Alamos, New Mexico, USA (17 Oct 1973).

Cytophotometry allows quantitation of individual cells and cell components. Absorption cytophotometry is compared with conventional spectrophotometry, the theory of scanning instruments is developed, and sources of error are identified. (auth)

2307 (UCRL-75556) COMPARISON OF THE SOUTHERN AND NORTHERN HEMISPHERE GENERAL CIRCULATION CHARACTERISTICS AS DETERMINED BY SATELLITE OZONE DATA. Lovill, J. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1974. 51p. (CONF-740106-4). Dep. NTIS $5.75.

From first special assembly of the International Association of Meteorology and Atmospheric Physics; Melbourne, Australia (14 Jan 1974).

2308 (UR-3490-457) EVALUATION OF THE INTERNATIONAL SYMPOSIUM ON BIOLOGIC EFFECTS AND HEALTH HAZARDS OF MICROWAVE RADIATION, WARSAW, POLAND, OCTOBER 15–18, 1973. Michaelson, S. M. (Rochester Univ., N. Y. (USA)). 1973. 27p. (CONF-740220-1). Dep. NTIS $4.50.

From conference on the biological effects of non-ionizing radiation; New York, New York, USA (11 Feb 1974).

Materials

2309 (BDX-613-735(Rev.)) VIBRATORY DEBURRING. Final Report. Gillespie, L. K. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1974. Contract AT(39-1)-613. 103p. Dep. NTIS $8.25.

The operation of small precision mechanisms such as timers, switches, or actuators depends on burr-free sharp-edged component parts. Traditional methods of producing these near-perfect edges on miniature parts are costly and not as precise or repeatable as some piecepart designs require. Vibratory deburring is capable of producing burr-free sharp edges on some miniature metal components; this investigation was initiated to determine the limitations and repeatability of the process and its effects on subsequent operations. This study concluded that the process can produce burr-free edges with edge radii of 0.003 ± 0.0015 inch on some materials; that smaller edge breaks or radii are not feasible on most parts; that suitability of the process is dependent upon piecepart geometry; and that the process can produce residual contamination on the workpiece that could be detrimental to subsequent operations, such as welding or plating. (auth)

2310 (BDX-613-931(Rev.)) PROTECTION OF GLASS TUBES IN EPOXY ENCAPSULATION. Steele, J. W. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1974. Contract AT(29-1)-613. 78p. Dep. NTIS $7.00.

A glass electron tube was breaking during a thermal cycle test after being potted in glass microballoon filled epoxy. Encasement requirements were established, experiments were designed, and information accumulated. After data from experiments was studied, two proposed designs were evaluated and one, a closed cell silicone rubber sponge extruded sleeve, was found to provide the required tube protection. (auth)

2311 (BDX-613-960(Rev.)) INVESTIGATION OF POLYSULFIDE CONFORMAL COATING. Final Report. Camp, C. J. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1974. Contract AT(29-1)-613. 21p. Dep. NTIS $4.25.

An investigation of the properties of foamed polysulfide (Thiokol) compounds revealed several properties that had previously escaped notice. These properties included lack of thermal stability, attack by hot epoxy resins, and differences among compounds prepared by different vendors. Details of these findings and their significance are discussed. (auth)

2312 (BDX-613-988(Rev.)) MECHANICAL DEBURRING OF PLASTICS. Final Report. Hishaw, R. J. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1974. Contract AT(29-1)-613. 33p. Dep. NTIS $4.75.

Hand deburring has been used to remove mold flash and machining burrs from relatively small parts molded from both thermosetting and thermoplastic resins. In an effort to reduce the time and manpower required for deburring, abrasive blast, flame, tumble, vibratory, slurry, putty extrusion, explosive, and cryogenic deburring were studied. Abrasive blasting was found to be the most efficacious and to have the broadest application. Tumble and vibratory deburring are effective on burrs on external surfaces. (auth)

2313 (BDX-613-1044) NONDESTRUCTIVE METHODS FOR THE ACCEPTANCE OF PLATING THICKNESS ON PRINTED CIRCUIT BOARDS. Abel, A. B. (Bendix Corp., Kansas City, Mo. (USA)). [nd]. Contract AT(29-1)-613. 20p. Dep. NTIS $4.00.

The first method described is the beta-backscatter measurement of copper thickness on the surface of the printed circuit board panels. The second nondestructive technique is the resistance measurement of plated through holes. Thirdly, a nondestructive test method that was applied is a modification of the plated through hole resistance tester. Lastly, the use of a light section microscope to measure the path width and thickness of printed circuit boards is discussed. The practical experience of a user of these techniques in nondestructive measurement and in-process control of plating thickness on printed wiring boards is desired. (MCW)

2314 (BDX-613-1065(Rev.)) NONMETALLIC TOOLING CAPABILITIES AND ECONOMICS. Final Report. Freund, R. W. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 15p. Dep. NTIS $4.00.

Nonmetallic materials are both useful and economical for many manufacturing tools and encapsulation molds. RTV silicon-rubber molds cast from machined metal mold masters are capable of reproducing complex shapes and intricate detail. Microballoon-filled epoxy molds can maintain closer tolerances on the molded parts, but are prone to break when removing the parts from the molds. High-impact polycarbonate assembly fixtures provide all of the functions required for most cable-assembly operations at less cost and procurement time. Nonmetallic molds and fixtures are particularly attractive for prototypes and small-quantity manufacturing, but also are economical for many normal production applications. Nylon potting shells for rack-and-panel connectors provide potential cost savings over conventional metal molds. (auth)

2315 (BDX-613-1067(Rev.)) INSULATION REMOVAL FROM WOVEN-WIRE TAPE. Naney, R. L. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 22p. Dep. NTIS $4.25.

The best method was determined for stripping a two-layer polyester insulation from selected areas of a 90-strand AWG-33 multiconductor woven-wire tape. Only two of several methods evaluated were capable of stripping the insulation completely without degrading the copper. Both chemical stripping and laser stripping produced acceptable results; however, laser stripping is faster and eliminates the tedious task of removing the residue of the chemical stripping process. Reduced wire damage and lower processing cost also are potential advantages. (auth)

2316 (BDX-613-1068(Rev.)) FLEXCIRCUIT PROTECTIVE COATINGS. Hile, R. A. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 19p. Dep. NTIS $4.00.

Protective coatings for use on Kapton-insulated flexcircuits were evaluated for abrasion resistance, tear strength, and flexibility. Tests were run on seven different protective coatings before and after a 300°F (149°C), 16-hour temperature cycle. Functional testing of the three most desirable protective coatings was performed on a typical flexcircuit used for a current application. On the basis of tests performed on the seven protective coatings, batiste, Tuftane, and nylon are useable for flexcircuit protection. (auth)

2317 (BDX-613-1103(Rev.)) PREDICTING COMPRESSIVE STRENGTH OF URETHANE FOAMS AT HIGH STRAINS. Final Report. Neet, T. E. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 17p. Dep. NTIS $4.00.

Equations for predicting the restrained compressive strength of rigid urethane foam at any density and strain were developed. General equations representing all of the foam systems studied were defined for foam strengths at –65 and 77°F (–54 and 25°C), while no general equation could be developed for the foams tested at 250°F (121°C). (auth)

2318 (BNL-tr-555) PHASE TRANSITION IN A GENERALIZED ONE-DIMENSIONAL ISING MODEL. Azbel, M. Ya. (AN SSSR, Moscow. Inst. Teoreticheskoj Fiziki). 1973. Translated by S. J. Amoretty from LITP-4715. 10p. Dep. NTIS $3.00.

The thermodynamics of a heteropolymer—a linear two-component system in three dimensions—was constructed without any assumptions about the sequence of the components. The phase transition in the system, which depends on the sequence,

can be either finite or discontinuous. In the latter case, the distribution function for the concentrations is determined directly. (auth)

2319 (CALT-767-P-3-34) STUDY OF DISLOCATION MOBILITY AND DENSITY IN METALLIC CRYSTALS. Final Report. Vreeland, T. Jr.; Lau, S. S. (California Inst. of Tech., Pasadena (USA). W. M. Keck Lab. of Engineering Materials). 1 Feb 1974. Contract AT(04-3)-767. 28p. Dep. NTIS $4.50.

2320 (CEA-CONF-2520) PROBLEMS POSED BY THE PREPARATION OF HOMOGENEOUS LAYERS OF IRON–SILVER ALLOY BY COPULVERIZATION. Sella, C.; Tertian, L.; Regnier, P.; Le Bian, A. (Centre National de la Recherche Scientifique. 92–Meudon-Bellevue (France). Lab. de Physique des Materiaux). 1973. 6p. (In French). (CONF-731061-1). Dep. NTIS (U. S. Sales Only) $3.00.

From international colloquium of cathodic pulverization; Montpellier, France (2 Oct 1973).

Preliminary studies on the preparation of homogeneous layers of Fe–Ag with 50–50 at. % composition by copulverization seemed to indicate that this technique gave thin layers with very fine grains. However the attempt to prepare thick layers resulted in the blackening of the Ag foil after about 30 to 60 min of pulverization and the pulverization yield of Ag then approaches zero. The evolution of this contamination of the Ag with the Fe was followed. If foils of Ag and Fe are placed side by side the contamination of the Ag surface by fine Fe crystallites causes the formation of cones or systems of cones and shelves. (JSR)

2321 (CEA-CONF-2548) GENERAL SURVEY OF POINT DEFECTS. Quere, Y. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). 1973. 64p. (In French). (CONF-730685-1). Dep. NTIS (U. S. Sales Only) $5.25.

From summer school on lattice imperfections; Zakopane, Poland (17 Jun 1973).

Some typical point defects in the three classical cases of ionic, metallic, and covalent crystals are described. Elastic models, computer simulations, some direct experimental evidences of point defects, and some phenomena directly governed by point defects are discussed. (46 references) (MCW)

2322 (COO-1790-6) "IN-SITU" ELECTRON MICROSCOPE INVESTIGATION OF THE NUCLEATION AND GROWTH OF SPUTTERED THIN FILMS. Annual Technical Progress Report VI. Hutchinson, T. E.; Maa, J.; Lee, J. I. (Minnesota Univ., Minneapolis (USA). Dept. of Chemical Engineering and Materials Science). 15 Jan 1974. Contract AT(11-1)-1790. 40p. Dep. NTIS $5.00.

The study of silver and gold on single crystal substrates of silicon has uncovered an important feature of substrate-overgrowth interaction leading to alloy formation. This gives rise in both cases to films that must have much higher resistivity values than would be expected for non-interacting films of comparable thickness although they do form epitaxial films. Ion beam damage and annealing studies of the substrate clearly indicate the importance of careful annealing of silicon substrates in order to attain epitaxial recrystallization of the damaged silicon layer. (auth)

2323 (COO-2172-3) GRAIN BOUNDARY SLIDING AND STRUCTURE. Progress Report, December 1, 1972–November 30, 1973. Li, C. Y. (Cornell Univ., Ithaca, N. Y. (USA). Dept. of Materials Science and Engineering). 1 Sep 1973. Contract AT(11-1)-2172. 14p. Dep. NTIS $3.00.

2324 (COO-3151-37) SECONDARY HIGH PRESSURE STANDARD FOR THE FAR-INFRARED SPECTRAL REGION. Report No. 2170. Smith, B. T.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. (USA). Lab. of Atomic and Solid State Physics). Feb 1974. Contract AT(11-1)-3151. 6p. Dep. NTIS $4.00.

The defect lattice mode in NaCl : Cu^+ provides a convenient secondary pressure standard for far infrared measurements of solids at low temperatures. (auth)

2325 (COO-3158-27) INTERATOMIC POTENTIALS AND DEFECT ENERGETICS IN DILUTE ALLOYS. Report No. 2158. Ho, P. S.; Benedek, R. (Cornell Univ., Ithaca, N. Y. (USA)). 20 Dec 1973. Contract AT(11-1)-3158. 36p. Dep. NTIS $5.00.

Effective interatomic potentials for impurities in aluminum were constructed according to the pseudopotential theory. Based on a local model potential, impurity valence and size factors were defined and their effects on the potential are discussed. Using these potentials, detailed calculations based on a Green's function lattice statics method were made for the impurity-vacancy binding energy and the difference in diffusion activation energies for an impurity and a host atom. The results can account satisfactorily for the experimental data of nontransition impurities, but less so for the noble-metal impurities. Contributions from the lattice relaxation energies are important, particularly for impurity migration. Dielectric screening of the ion by the conduction electrons is important in determining the potential and must be properly accounted for in calculating the energetics for impurities. (auth)

2326 (COO-3166-6) HYDROGEN BRITTLENESS IN HYDROGEN AND HYDROGEN–OXYGEN GAS MIXTURES. Johnson, H. H. (Cornell Univ., Ithaca, N. Y. (USA). Dept. of Materials Science and Engineering). [nd]. Contract AT(11-1)-3166. 31p. (CONF-730605-3). Dep. NTIS $4.75.

From international conference on stress corrosion cracking and hydrogen embrittlement of iron base alloys; Unieux-Firminy, France (10 Jun 1973).

Crack initiation and propagation characteristics are presented for high strength steels in hydrogen and hydrogen-oxygen mixtures under both static and cyclic stress. Under static stress and in hydrogen the threshold stress intensity for crack initiation was nearly independent of temperature in the range around 300°K; however, the crack growth rate was a maximum near 300°K and decreased at both higher and lower temperatures. Oxygen in the amount of 0.4% by volume eliminated hydrogen-induced slow crack growth; at lower concentrations the threshold stress intensity was approximately linear with oxygen concentration. Under cyclic stress hydrogen-accelerated fatigue crack growth was observed for 4340 steel with yield strengths from 150 to 215 KSI. Oxygen additions eliminated the hydrogen-accelerated growth at the lower strength levels, but was only partially inhibitory at a yield strength of 215 KSI. Possible hydrogen concentration profiles by diffusion ahead of the crack tip were calculated for two models. In the first the crack tip is modelled as a moving line source for hydrogen, and in the second as a moving semi-infinite slit source. In both models the penetration distance depends upon the ratio of the diffusivity to the crack growth velocity. (auth)

2327 (COO-3407-8) DISLOCATION MOBILITIES IN ORDERED ALLOYS. Annual Progress Report. Pope, D. P. (Pennsylvania Univ., Philadelphia (USA). Dept. of Metallurgy and Material Science). 26 Mar 1974. Contract AT(11-1)-3407. 21p. Dep. NTIS $4.25.

Dislocation velocity measurements carried out on Cu_3Au at 298 and 77°K show that dislocations do not move until the applied stress is approximately the macroscopic yield stress, and when that stress is reached the velocity increases rapidly with stress. The velocity-stress relations measured at 77 and 298°K are not very different. This mobility data was used to reinterpret the anomalous temperature dependence of the yield stress and work hardening rates in Ll_2 alloys. It is shown that the low temperature yield stress is probably determined by the antiphase boundary energy, and the increasing yield stress with temperature (in alloys that do not disorder) is related to a cross-slip pinning mechanism. The work hardening rates are determined by a combination of cross slip-pinning and antiphase boundary tube hardening. (auth)

2328 (FRNC-CONF-94) AMORPHIZATION, RECRYSTALLIZATION, AND ELECTRICAL ACTIVITY OF IMPLANTED Si LAYERS. Prisslinger, R.; Kalbitzer, S.; Grob, J. J.; Siffert, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg (F. R. Germany); Centre National de la Recherche Scientifique, 67–Strasbourg (France). Centre de Recherches Nucleaires). 1973. 24p. (In French). (CONF-730574-12). Dep. NTIS (U. S. Sales Only) $3.25.

From congress on the centenary of the French Physics Society; Vittel, France (28 May 1973).

The dose of $^{28}Si^+$ ions (10 to 60 keV) necessary to make a Si monocrystal amorphous was studied using charged-particle backscattering measurements. The value obtained at 300 K was between 1 and 3.10^{15} cm^{-2}; this value is larger than those already obtained using the same technique, but quite close to those obtained using other methods. Similar results were obtained for other ions having similar masses ($^{27}Al^+$, ^{31}P). An analysis of the recrystallization of the bombarded zones effected after annealing at 1100 C revealed the effect of the nature of the ions. It was also found that doses exceeding the threshold to make the material amorphous result in a different type of recovery at high temperatures. (auth)

2329 (FRNC-TH-448) APPLICATION OF THE MOESSBAUER EFFECT TO STUDIES OF INVAR TYPE IRON–NICKEL ALLOYS. Rechenberg, H. (Grenoble-1 Univ., 38 (France)). 1973. 196p. (In French). Dep. NTIS (U. S. Sales Only) $13.00.

Thesis.

The Moessbauer effect was used to study the magnetic and structural properties of fcc iron-nickel alloys containing less than 50% iron. These invar-type alloys were studied from two distinct but complementary points of view: the spatial fluctuations of the hyperfine field of iron, such fluctuations revealing

a special character in the case of invar for which a microscopic model is proposed; the effect of the metallurgical state on the magnetic properties of invar. The fcc structure of these alloys corresponds to a metastable state that can be modified by electron irradiation. The effects of irradiation on invar were studied together with the properties of powdered samples. (tr-auth)

2330 (ITF-73-142-E) SHAPE OF THE BAND OF LIGHT ABSORPTION BY AN IONIC CRYSTAL IN THE EXCITON REGION. Lubchenko, A. F.; Nitsovich, V. M.; Tkach, N. V. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1973. 16p. Dep. NTIS (U. S. Sales Only) $4.00.

The Bogolyubov–Tyablikov method is used to calculate the retarded two-time exciton Green's function with a simultaneous consideration of linear and quadratic terms of the exciton–phonon interaction. It is shown that in the case of a weak coupling of exciton with phonons the light absorption band is of a quasi-Lorentzian shape and the temperature genesis of its parameters uniformly depends on linear φ and quadratic ϕ coupling functions. (auth)

2331 (ITF-73-156-P) MODERN METHODS OF QUANTUM THEORY IN THE ISING MODEL. Spin–Photon Interaction in the Ising Model. Zagrebnov, V. A.; Fedyanin, V. K. (AN Ukrainskoj SSR, Kiev, Inst. Teoreticheskoj Fiziki). 1973. 44p. (In Russian). Dep. NTIS (U. S. Sales Only) $5.25.

Within the formalism of quantum statistical Green's functions the influence of lattice oscillations on the character of phase ferromagnet-paramagnet transformation is investigated. (auth)

2332 (ITF-73-158-P) MODERN METHODS OF QUANTUM THEORY IN THE ISING MODEL. Zagrebnov, V. A.; Fedyanin, V. K. (AN Ukrainskoj SSR, Kiev, Inst. Teoreticheskoj Fiziki). 1973. 36p. (In Russian).

Calculation methods of the so-called "critical indices" (exponents) in the Ising model are described. (auth)

2333 (JUL-1039-FF) ELASTIC INTERACTION AND PHASE TRANSITION IN COHERENT METAL–HYDROGEN SYSTEMS. Wagner, H.; Horner, H. (Kernforschungsanlage Juelich G.m.b.H (F.R. Germany). Inst. fuer Festkoerperforschung). Jan 1974. 106p. Dep. NTIS (U. S. Sales Only) $8.50.

Some general properties of the elastic interaction and the importance of boundary conditions for the form of the elastic interaction, which turns out to be of the Curie–Weiss type with macroscopic range, are discussed. The $\alpha-\alpha'$ ("gas-liquid") phase transition in the hydrogen lattice fluid is investigated. The long-range part of the elastic interaction is treated in mean field approximation. In the canonical ensemble as opposed to the grand canonical ensemble, no coexisting phases near the critical point are found. Instead there is a continuous transition that changes into a first-order transition at tricritical points. In the temperature-density region that normally corresponds to the two-phase coexistence region the hydrogen density is inhomogeneous and varies on a macroscopic scale. (MCW)

2334 (LA-UR-74-273) RESPONSE OF IRON TO DYNAMIC COMPRESSION. Hockett, J. E.; Zukas, E. G. (Los Alamos Scientific Lab., N. Mex. (USA)). 1973. 29p. (CONF-740413-1). Dep. NTIS $3.50.

From conference on the mechanical properties of materials at high rates of strain; Oxford, UK (2 Apr 1974).

Compressive true stress-strain curves were determined for annealed iron at constant true-strain rates from 10^{-2} to 2×10^{2} sec^{-1}, over a range of temperatures from 253 to 873 K, to true strains of about 0.7 (50% compression). The response of iron to dynamic compression was manifested by its resistance to deformation and by its mode of deformation. For a given temperature, an increase in the true-strain rate resulted in an increase in the flow stress, or resistance to deformation, at low strains (below about 0.4); however, at large strains (0.6–0.7) the flow stress was affected very little by strain rates. For a given strain rate, an increase in temperature (from 0.16 to 0.49 T_m) produced a decrease in flow stress at low strains and a proportionately smaller decrease at large strains. The mode of deformation was revealed by metallographic examination of all deformed specimens: at high strain rates or at low temperatures, a large amount of mechanical twinning occurred. At higher temperatures and/or lower strain rates, deformation was either predominantly by slip or completely by slip. (auth)

2335 (LBL-2547) STEADY STATE CREEP IN Pb–Sn EUTECTIC ALLOYS. Grivas, D. I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1974. Contract W-7405-eng-48. 47p. Dep. NTIS $5.50.

Thesis.

Steady state creep rates were measured for the superplastic lead-tin eutectic alloy (Pb-62Sn). Tests were performed on samples of grain size from 2.8 μm to 9.9 μm over a range of temperatures from 0 to 160°C and strain rates from $1.8 \cdot 10^{-7}$ to $1.33 \cdot 10^{-2}$ sec^{-1}. The alloy exhibited three different regions of constant value for the stress exponent n. The data were consistent with the assumption that the creep behaviors occur simultaneously via independent mechanisms. At high stresses, conventional creep was found to be the dominant mechanism while at intermediate stresses it was superplastic creep. At low stresses against the general belief a non-diffusional mechanism was found to control the creep rates of this alloy. (auth)

2336 (MHSMB-37) RECOVERY OF HMX FROM SCRAP PBX-9404 HIGH EXPLOSIVE. Technical Report No. 219. Leake, E. E. (Mason and Hanger-Silas Mason Co., Inc., Burlington, Iowa (USA). Development Dept.). 26 Oct 1973. Contract W-49-010-AMC-68(A). 44p. Dep. NTIS $4.25.

An investigation of the feasibility of recovering the explosive cyclotetramethylene-tetranitramine (HMX) from scrap plastic bonded explosive PBX-9404 is described. Laboratory studies led to the establishment of a technically feasible recovery process that utilizes concentrated nitric acid under closely controlled temperature conditions to effect elimination of the binder and was pilot tested to establish scale-up information. Recovery costs, using Burlington AEC Plant scrap PBX-9404 quantity projections as a base, were determined to be approximately $3.75 per pound of recovered HMX. The cost of new HMX is in the dollar per pound class. The process is considered to be technically feasible but not economically attractive at this time. (MCW)

2337 (MHSMP-74-5-A) STUDY OF FERRIC ACETYLACETONATE AND OTHER CATALYSTS IN THE CURING AGENT FOR ADIPRENE L-315. Foster, P. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 8p. Dep. NTIS $4.00.

A mixture of 1,4 butanediol, trimethylolpropane and ferric acetylacetonate is being used to cure Adiprene L-315; problems have been encountered with water, nonuniformity of the curing time, and a precipitate forming in the curing mixture. A study of these problems was made and the results are reported. The cure time of Adiprene L-315 using 1,4 butanediol and trimethylolpropane with other catalysts was also studied to determine if the cure time could be reduced from 16 hours to approximately six hours. The catalyst, Dabco, gave the desired cure time. (auth)

2338 (MHSMP-74-5-C) SLOW PBX AND PLANE WAVE LENS DEVELOPMENT. Crutchmer, J. A.; Canada, C. E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 18p. Dep. NTIS $4.00.

Ten batches of baratol and Comp B-3 were made and analyzed. Twelve billets were pressed from this material for plane wave lenses and fire pads. Two 8-inch diameter plane wave lenses, P/081 Mod 1-D, using Comp B-3 as the fast component and 76/24 BN/TNT baratol as the slow component, were fired and analyzed. Two 8-inch diameter P/081 Mod II, and three 4-inch diameter P/040 Mod III-B plane wave lenses were fired and analyzed. These lenses used PBX 9404 as the fast component and 85/15 BN/TNT baratol as the slow component. Experimental work has started to quantitate shock wave propagation through the components of a PWL. Results for P/040 Mod. III PWL's indicate the PBX 9404 to be initially underdriven; a run-to-detonation distance of 0.25 inch was observed. The shock velocity in the baratol component, however, was still faster than expected despite underdrive in the first HE component. Two optical tests were made to determine pressure distribution across the output surface of a P-016 lens. These tests were unsuccessful due to insufficient illumination for film exposure. (auth)

2339 (MHSMP-74-5-D) DRIVER ASSEMBLIES RDX/SYLGARD INVESTIGATION. Faubion, B. D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 6p. Dep. NTIS $4.00.

Studies of RDX and RDX/Sylgard in relationship to their use in an alternate explosive train system for neutron generator driver assemblies have continued. An analytical method for the determination of RDX in the Sylgard matrix has been developed and several batches of RDX/Sylgard have been analyzed. Coupon test samples were also being prepared in order to evaluate the long-term compatibilities of the components in MC-2453. No significant differences in the aging characteristics of RDX due to HMX or occluded solvent were observed after two months. (auth)

2340 (MHSMP-74-5-E) PETN AND LX-13 PROCESSING. Osborn, A. G.; Stallings, T. L.; Locke, J. G.; Duncan, A. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 6p. Dep. NTIS $4.00.

Experiments were conducted to determine if the milling process was adversely affecting extrudability of the LX-13 made from

PETN precipitated by the continuous flow process. Extrudability results indicated that the milling process had no adverse effects on extrudability. (auth)

2341 (MHSMP-74-5-F) RDX/SYLGARD. Slape, R. J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 16p. Dep. NTIS $4.00.

To provide a starting material for future formulations, approximately 50 pounds of RDX was purified. Using this material five batches of RDX were recrystallized using the continuous precipitation process yielding batches of varying particle characteristics from which seven batches of 85/15 RDX/Sylgard 182 were formulated. The 85/15 composition was previously determined so as to tailor the RDX/Sylgard 182 output to match that presently obtained from the standard tetryl output pellet driver subassembly. These seven RDX/Sylgard batches were tested in the newly installed Instron MCR Capillary Rheometer in a search for batch-to-batch variations. (auth)

2342 (MHSMP-74-5-G) PASTE PROCESSING. Osborn, A. G.; Stallings, T. L.; Slape, R. J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 4p. Dep. NTIS $4.00.

The MCR Capillary Rheometer is being evaluated for characterizing the rheological properties of paste explosive. Seven batches of PEX were made. Processing variables included both oven dried and freeze dried material from two lots of HMX and the preparation of the EDNP/Cab-O-Sil premix using the Colloid Mill. (auth)

2343 (MHSMP-74-5-H) PETN RECRYSTALLIZATION STUDY. Foster, P. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 28p. Dep. NTIS $4.50.

Pentaerythritol tetranitrate (PETN) was crash recrystallized to study the effects of drying temperature, drying time, stirring rate, impurities, and removal time from the water on the crystal habits. Particle size measurements were made on the recrystallized PETN and these data were analyzed by factorial analysis and stepwise regression to determine which variables have the greatest effect on particle characteristics. (auth)

2344 (MHSMP-74-5-I) HE PRESSING. Harrell, J. D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 3p. Dep. NTIS $4.00.

An inert mixture has been pressed into billets by the triaxial process. Densities are compared to the conventional wet-bag process when compacted at pressures of 10, 15, and 20 kpsi. Billets pressed by the triaxial process have a density that is higher by at least 53 mg/cc. (auth)

2345 (MHSMP-74-5-J) LX-13 COMPONENT SEPARATION IN SILK SCREEN EXTRUSION. Clink, G. L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 5p. Dep. NTIS $4.00.

Compositional gradients in extruded LX-13 tracks are being studied by means of NMR analysis. Significant changes in the percentage makeup of the PETN/Sylgard admixture was found to occur in the extrusion residues left on the silk screens. Analysis of the LX-13 tracks is underway. (auth)

2346 (MHSMP-74-5-K) NMR ANALYSIS OF RX-08-DR (PEX). Clink, G. L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 4p. Dep. NTIS $4.00.

The application of NMR spectrometry to the analysis of RX-08-DR, a paste explosive (PEX) has shown itself to be an acceptable method, both economically and time wise. Dissolution of PEX in acetone, with addition of high purity PETN as an internal standard, precedes the NMR analysis in a normal manner. (auth)

2347 (MHSMP-74-5-L) X-RAY DIFFRACTION STUDIES. Blair, C. C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 5p. Dep. NTIS $4.00.

2348 (MHSMP-74-5-M) HIGH PURITY PETN AND TRACE IMPURITY ANALYSIS. Sandoval, J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 3p. Dep. NTIS $4.00.

Ultra-pure pentaerythritol tetranitrate, PETN, can be isolated through crystallization, extraction, and chromatographic procedures; however, the composition of such product cannot be ascertained until analytical techniques currently in use are improved. (auth)

2349 (MHSMP-74-5-N) PARTICLE CHARACTERIZATION. Duncan, A. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 8p. Dep. NTIS $4.00.

Milling studies have been started on LX-13 and XTX-8003 formulations where particle characterization is performed following various mill-passes under different milling conditions. Milling variables studied have been roller-gap, roller-speed, and the use of freon M. F. The particle characteristics for eight batches of LX-13 or XTX-8003 measured at various mill-passes are given. (auth)

2350 (MHSMP-74-5-O) HE PARTICLE CHARACTERIZATION FOR QUALITY CONTROL. Giberson, R. C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 8p. Dep. NTIS $4.00.

Special studies of the effect of roll milling on LX-13 particle size were conducted and it was found that the PETN particle size was significantly reduced during roll milling with the largest reduction occurring in the initial five passes through the mill. Studies were initiated using the light pen on HNAB. (auth)

2351 (MHSMP-74-5-P) DEVELOP AND IMPLEMENT METHODS FOR DESTRUCTIVE TESTS. Kramer, P. E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 5p. Dep. NTIS $4.00.

The detonation electric effect was employed on C-J pressure aquarium shots, with the purpose of eliminating the need for optical coverage. Excellent agreement was obtained between measured and predicted C-J pressure for PBX 9404 using this technique. The detonation electric effect is also being employed to improve early-time data acquisition on wedge tests. Initial results indicate that the technique will be useful in determining unreactive Hugoniots of HE's. A fixture for wedge testing of PEX has been designed and built, but testing cannot proceed until some questions about compatibility have been investigated. (auth)

2352 (MHSMP-74-5-Q) MATHEMATICAL ANALYSIS OF HE DATA. Ashcraft, R. W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 5p. Dep. NTIS $4.00.

The analysis of a fractional factorial experiment on PETN recrystallization and a computer simulation of the Henkin test with Code TRUMP is made. The purpose of the simulation was to determine if the Henkin test was amenable to mathematical modeling. If this were true, the TRUMP code could then be used to accurately predict experimental results, thus reducing the necessary amount of laboratory work. The Henkin test setup was found to be too complex for mathematical modeling in the TRUMP code. Results obtained using a simplified model produced poor agreement with experimental results. (auth)

2353 (MHSMP-74-6-A) PBX PROCESSING. Osborn, A. G.; Stallings, T. L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 5p. Dep. NTIS $4.00.

For Lawrence Livermore Lab., Livermore, CA.

Five batches of HMX/Estane PBX were made supplying approximately 1000 pounds of material for evaluation and test purposes. (auth)

2354 (MHSMP-74-6-B) EXPLOSIVES PERFORMANCE AND SENSITIVITY. Kramer, P. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 3p. Dep. NTIS $4.00.

For Lawrence Livermore Lab., Livermore, CA.

A one-inch diameter cylinder shot was fired with LX-10-1. The streak record of the expansion has not yet been analyzed. Investigation of the velocity discrepancy between cylinder shots fired at Pantex and LLL continued. Two shots (not yet analyzed) were fired with LX-10-0 Lot 951-7 for comparison with a previously fired "acceptable" shot. A study of old records appears to have eliminated some more possible sources of error. (auth)

2355 (MHSMP-74-6-C) HE FRICTION SENSITIVITY. Van Velkinburgh, J. H. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 35p. Dep. NTIS $4.75.

For Lawrence Livermore Lab., Livermore, CA.

An extensive series of instrumented skid tests was done on RX-04-E1 and RX-04-EJ (98/2 and 99/1 HMX/Vistanex by weight respectively). Several skid tests were done using RX-04-EM (96.6/3.4 HMX/Estane by weight). Skid test sensitivity was deemed acceptable. Friction machine tests were done using RX-04-EE (95/5 HMX/Estane by weight). Results are presented and discussed. (auth)

2356 (MHSMP-74-6-D) THERMAL PROPERTIES, REACTIVITY AND COMPATIBILITY. Myers, L. C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 38p. Dep. NTIS $5.00.

For Lawrence Livermore Lab., Livermore, CA.

Preliminary thermal decomposition tests were made with PETN at 100 C and the results show products other than N_2, CO, NO, CO_2 and N_2O. There is evidence that ethanol is present as a decomposition product. The chemical reactivity test data for three LLL requests are reported. Visual observations, gas analysis of the atmosphere, and chemical reactivity are reported for disassembled LX-09 and LX-10. (MCW)

2357 (MHSMP-74-6-E) MECHANICAL PROPERTIES OF EXPLOSIVES. Johnson, H. D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 29p. Dep. NTIS $4.50.

For Lawrence Livermore Lab., Livermore, CA.

The resistance to creep of LX-09-1 Lot 700-10 and LX-10 Lot 710-4 was vastly improved by subjection to the bartherm treatment for 10 days. Minor density improvements were also observed after bartherm treatment. Test results showed that there were no significant differences in time-to-failure and strain-at-failure for speciments bartherm treated for more than ten days. (auth)

2358 (MHSMP-74-7) DETONATION VELOCITY AND PRESSURE OF 1/2-INCH DIAMETER HNAB PELLETS. Warren, T. W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 7p. Dep. NTIS $4.00.

For Sandia Labs., Albuquerque, NM.

Empirical relationships of detonation velocity and pressure to density have been derived for representative 1/2-inch diameter HNAB pellets in a density range of 80 to 95 percent TMD: $D = -5.2333\ \rho^2 + 18.5785\ \rho - 9.0327$, $P = 217.936\ \rho - 143.621$; $1.40 < \rho < 1.65$ g/cm^3. Performance parameters of HNAB are shown to closely approximate those of Tetryl in 1.60 g/cm^3 pellets. (auth)

2359 (MHSMP-74-8) ANALYSIS OF S-TRICHLOROTRINITROBENZENE AND 1,3,5-TRINITRO-1,3,5-TRIAZACYCLOHEXANE SAMPLES BY LIQUID CHROMATOGRAPHY. Quinlin, W. T. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 10p. Dep. NTIS $4.00.

For Sandia Labs., Albuquerque, NM.

2360 (ORNL-4956) PREPARATION, TESTING, AND ANALYSIS OF ZINC DIFFUSION SAMPLES, NASA SKYLAB EXPERIMENT M-558. Braski, D. N.; Kobisk, E. H.; O'Donnell, F. R. (Oak Ridge National Lab., Tenn. (USA)). Apr 1974. Contract W-7405-eng-26. 60p. Dep. NTIS $5.45.

2361 (ORNL-tr-2757) EXAMINATION OF METHODS FOR EXTRAPOLATING RUPTURE STRENGTH OF HEAT RESISTANT STEELS. Granacher, J.; Wiegand, H. Translated by R. G. Mansfield from Arch. Eisenhuettenw.; 43: No. 9, 699-704(1972). 13p. (CONF-7205105-1). Dep. NTIS $3.00.

From international meeting on properties of high temperature steels; Dusseldorf, F. R. Germany (3 May 1972).

A review is given of methods proposed for extrapolation. Classification of methods with respect to the procedure (graphic, graphic-numerical, numerical) and the amount of information used; requirements as to range and number of rupture data for extrapolation; and the importance of shortened tests for examination and comparison of extrapolation methods are discussed. Brief discussions of the parameters of shortened tests; extrapolation parameters, especially the time ratio; new numerical methods; and new rupture tests are presented. (28 references) (MCW)

2362 (ORNL-tr-2762) MARTENSITIC TRANSFORMATIONS IN AUSTENITIC STAINLESS STEELS Fe-Cr-Ni (RELATION BETWEEN THE PHASE ELEMENT OF PARAMETERS AND THE TRANSFORMATION MECHANISMS). Blanc, G.; Ticcot, R.; Castro, R. Translated by Martha Gerrard from Mem. Sci. Rev. Met.; 70: 527-541(1973). 23p. (CONF-721063-8). Dep. NTIS $3.25.

From autumn meeting on metallurgy; Chatenay-Malabry, France (2 Oct 1972).

The austenitic stainless steels Fe-Cr-Ni, type 18/8, may undergo martensitic transformation due to plastic deformation at a lower temperature than the point M_d or by maintenance at a low temperature ($T < M_s < M_d$). The transformation products consist of the ϵ phase (hexagonal compact) and the α' (cubic centered). Phase analyses and micrographic observations (optical and electron microscopy on thin cuts) show the presence of two competitive mechanisms: (1) transformation through the ϵ phase, $\gamma \rightarrow \epsilon \rightarrow \alpha'$, and (2) direct transformation, $\gamma \rightarrow \alpha'$, involving $\gamma \rightarrow \epsilon$. The result of this competition is governed by the more or less great ease of formation of the ϵ phase and by its aptness to be converted to the α' phase. This aptness is directly related to the parameters of the ϵ phase and especially to the parameter c. The nature of the intermediate phase is more marked as the parameter decreases from its theoretical value (4.15 Å) to approach a value clearly smaller (4.08 Å), for which the dense planes of the ϵ phase are not separated from those of austenite but have dense planes of the ϵ phase. In this case the transformation $\epsilon \rightarrow \alpha'$ can occur without formation of new dislocations. (auth)

2363 (ORO-3808-28) DYNAMIC DISLOCATION PHENOMENA IN SINGLE CRYSTALS OF METALS AND ALLOYS. Final Report. Mitchell, J. W. (Virginia Univ., Charlottesville (USA). Dept. of Physics). 1973. Contract AT(40-1)-3808. 46p. Dep. NTIS $5.50.

The study comprised nine areas on: the growth and characterization of single crystals of α-phase copper-aluminum alloys of high purity and perfection; the second and third order elastic constants of these alloys as a function of composition; source activation and dislocation motion in the earliest stages of plastic deformation immediately below the yield point; the dislocation mechanism involved in the formation of bands of deformation at the yield point; dynamic dislocation phenomena and mean dislocation velocities during the formation of bands of deformation at the yield point; internal stress distributions associated with arrays of dislocations; the mechanical properties of dilute ternary copper alloys such as the copper-aluminum-nickel alloy system; the factors determining the limiting velocities and frictional forces acting on dislocations from measurements of ultrasonic attenuation; and the factors determining the resistivity increment due to edge dislocations in alloys. The procedures and results are described and forty papers that have been published concerning the research are listed. (MCW)

2364 (SLA-73-1045) EFFECT OF SOLDERING FLUX ON Ta_2N RESISTORS. Hof, G. J. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 18p. Dep. NTIS $4.00.

Assembly by soldering results in the presence of excess flux that is normally removed with alcohol or trichloroethylene. In hybrid microcircuits solvents may be retained in crevices or voids. This study considers the effect of flux on Ta_2N resistors in hybrid microcircuits assuming that excess flux is not removed to avoid using solvents. Ta_2N resistors were tested for stability during heating in air at 150°C for 200 hours. Flux does cause a resistance value increase and excess flux removal is recommended. (auth)

2365 (SLA-73-1049) EVALUATION OF PRE-BOND ETCHANTS IN HYBRID MICROCIRCUIT PROCESSING. Holloway, P. H.; Long, R. L. Jr. (Sandia Labs., Albuquerque, N. Mex. (USA)). Nov 1973. Contract AT(29-1)-789. 67p. Dep. NTIS $6.50.

In order to remove a surface chromium oxide contaminant that interferes with thermocompression bonding, Sandia Laboratories presently uses a pre-bond chemical etching step in its hybrid microcircuit (HMC) processing. To solve a production processing problem, five different etchants were tested to determine which most effectively increased the thermocompression bondability of HMC's. Two different potassium iodide plus iodine etches were shown to be marginal in restoring bondability. Limited data on ceric ammonium sulfate and sodium cyanide etchants indicated they could restore bondability. Extensive data demonstrated that a ceric ammonium nitrate (CAN) etchant restored the bondability of HMC's, did not change the surface topography, did not cause thin film deadhesion, and did not cause deleterious effects during accelerated aging tests. The incorporation of CAN as the pre-bond etchant in HMC processing was recommended. (auth)

2366 (SLA-73-5677) HEAT TRANSFER IN HIGH TEMPERATURE OPACIFIED FIBER INSULATION. Rainhart, L. G.; Acton, R. U.; Donaldson, A. B. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 16p. (CONF-731106-6). Dep. NTIS $4.00.

From thirteenth international conference on thermal conductivity; Lake Ozark, Missouri, USA (5 Nov 1973).

Because of excessive carbon heat shield temperatures during vehicle reentry, it is necessary to thermally isolate the heat shield from the substructure. This is accomplished by a high temperature carbon fiber insulation. Under such conditions as high temperature, low bulk density, and low interstitial gas pressure, the net heat transfer is reduced by reducing the radiation component with graphite flake radiation barriers. The insulation, its manufacture, the thermal model that evolved for characterizing the heat transfer through the material, and the comparison of the model predictions with data as a function of the variable under study are described. (auth)

2367 (SLA-73-5805) SURFACE ELECTRONIC PROPERTIES AND THE SEARCH FOR NEW HYDROGEN OXIDATION CATALYSTS. Laramore, G. E.; Houston, J. E.; Park, R. L.

(Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 10p. (CONF-740306-3). Dep. NTIS $3.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

The development of cheap substitutes for the noble metals as oxidation catalysts provides alternatives to direct combustion in the utilization of hydrogen as an energy source. Current likely candidates are the transition metal carbides that have many of the desirable properties of the noble metals with respect to hydrogen oxidation and hydrogenolysis. In an attempt to understand this phenomenon and to perhaps systematize the search for new catalytic materials, the surface electronic properties of tungsten, tungsten carbide, and platinum have been measured and compared. (auth)

2368 (SLA-73-5810) HYDROGEN IN METALS: A NEW THEORETICAL MODEL. Switendick, A. C. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 12p. (CONF-740306-4). Dep. NTIS $3.00.

From hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

Calculations for cubic metal hydride structures have shown the factors contributing to stable hydride formation. Hydrogen perturbs a certain class of electronic states strongly, namely those associated with s-like character at the hydrogen site. The calculations enable determination of these states and their energy position and relate the stability of various hydride structures to the hydrogen locations and spacing, thus indicating a maximum hydrogen density. The implication of these results to the solubility of hydrogen in metals is discussed. (auth)

2369 (SLA-73-7074) IN-SITU TRANSPORT MEASUREMENTS ON UHV GROWN a-Ge SAMPLES. Knotek, M. L. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974. 11p. (CONF-740313-2). Dep. NTIS $4.00.

From international conference on tetrahedrally bonded amorphous semiconductors; Yorktown Heights, New York, USA (20 Mar 1974).

The annealing properties of both high and low substrate temperature (T_s) a-Ge samples were examined. The behavior of high T_s samples is seen to agree with those previously reported. The behavior for low T_s samples is shown to have a wide range of behavior that may or may not be a function of the vacuum during annealing. Depth profiles of oxygen and carbon from Auger spectroscopy have been obtained and results show that high oxygen levels exist in low T_s samples after annealing. In the low temperature regime it is shown that for the data the variable range tunneling mechanism explains the temperature, annealing, and thickness dependence of the conductivity quite well. Some inconsistencies which remain between the data and theory are noted. (auth)

2370 (SLA-74-5002) RESULTS OF THERMAL BATTERY CELL TESTING. Bush, D. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 11p. (CONF-740407-2). Dep. NTIS $4.00.

From 26th power sources symposium; Atlantic City, New Jersey, USA (29 Apr 1974).

2371 (SLA-74-5046) POWER THERMAL BATTERY FOR ARTILLERY. Grothaus, K. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). [nd]. 14p. (CONF-740407-3). Dep. NTIS $4.00.

From 26th power sources symposium; Atlantic City, New Jersey, USA (29 Apr 1974).

2372 (SLA-74-5094) THERMAL IGNITION OF PYROTECHNICS THROUGH A BULKHEAD. Kjeldgaard, E. A.; Gould, D. J. (Sandia Labs., Albuquerque, N. Mex. (USA)). [nd]. 14p. Dep. NTIS $3.00.

Thermal ignition of a pyrotechnic through a metal bulkhead under pressure has been accomplished by utilizing thin wall, small diameter tubing. The results from this investigation indicate that design of a reliable ignition system that will not leak under short term conditions of high pressure at elevated temperature is feasible. (auth)

2373 (SLL-74-5210) GAS MIGRATION IN GLASS. Shelby, J. E. (Sandia Labs., Livermore, Calif. (USA)). Mar 1974. Contract AT(29-1)-789. 33p. (CONF-740417-1). Dep. NTIS $4.75.

From structure of glass conference; Troy, New York, USA (Apr 1974).

Inert gas mobility and solubility are primarily determined by the accessible free volume of the glass structure. As a result, the compositional dependence of gas mobility in a given family of glasses is a function of the effect of compositional changes on the structure and is not determined simply by the concentration of network formers. The effect of thermal history on gas mobility can be explained in a similar fashion; volume relaxation results in a corresponding mobility relaxation. Phase separation affects gas mobility, applied tensile stress increases gas mobility near the breaking stress of the specimen, and compressive and shear stress have no effect on gas mobility. Hydrogen behaves like an inert gas at low temperatures, but reacts to form hydroxyl at higher temperatures. (auth)

2374 (SU-326-P-17-X-5) STRUCTURE DEPENDENCE OF HIGH TEMPERATURE DEFORMATION OF METALS. Progress Report, December 1, 1972–December 1, 1973. Nix, W. D.; Barrett, C. R. (Stanford Univ., Calif. (USA). Dept. of Materials Science and Engineering). 1 Jan 1974. Contract AT(04-3)-326. 85p. Dep. NTIS $7.25.

The relation between structure and high temperature creep and creep rupture of metals was examined. Superplastic flow in the Pb-Sn eutectic; fine grained refractory metals produced by physical vapor deposition using chromium; the influence of precipitation free zones on creep ductility using Al-Zn-Mg alloys; a theory of creep rupture based on void growth by plastic deformation; and an analysis of the entropy of thermally activated dislocation glide based on the theory of thermoelasticity are summarized. Publications, reports, and dissertations produced for the year are given. (47 references) (MCW)

2375 (UCID-16469) CRITICAL ENERGY FOR SHOCK INITIATION OF TETRYL AND A-5. Green, L. G.; Nidick, E. J. Jr.; Walker, F. E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Mar 1974. Contract W-7405-eng-48. 13p. Dep. NTIS $4.00.

Results of shock initiation experiments on tetryl and A-5 are presented. A gun system was used to produce both sustained and short-duration pressure pulses from which the critical energy for initiation for these explosives was calculated. For tetryl, the value was 420 ± 24 kJ/m^2. For A-5 the value was 528 ± 26 kJ/m^2. (auth)

2376 (UCRL-74832) HIGH PURITY GERMANIUM–LOW TEMPERATURE HALL ANALYSES. Wichner, R.; Swierkowski, S. P.; Armantrout, G. A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1973. 18p. (CONF-731112-32). Dep. NTIS $4.00.

From nuclear science symposium; San Francisco, California, USA (14 Nov 1973).

Results are given of low temperature (to ~7°K) Hall measurements on 58 samples of high-purity germanium obtained in the U. S., Canada, and Europe. The measurements show the presence of deep (Cu) and shallow level (Group III and V) chemical impurities as well as deep energy levels associated with complex vacancy and/or oxide defects. It was found that high-purity germanium tends to be rather well compensated, i.e., the individual acceptor or donor concentrations are typically 3 to 10 times that of the net carrier concentration at 77°K. Shallow-level impurity problems seem to be associated with Al most frequently, with some boron contamination observed. The presence of defect-related deep levels has also been observed. (auth)

2377 (UCRL-75209) TENSILE PROPERTIES OF AN ULTRAHIGH-STRENGTH GRAPHITE FIBER IN AN EPOXY MATRIX. Chiao, T. T.; Hamstad, M. A.; Jessop, E. S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Dec 1973. 15p. (CONF-740411-1). Dep. NTIS $3.00.

From conference on composite reliability; Las Vegas, Nevada, USA (15 Apr 1974).

The fiber performance and potential as a reinforcement for fiber composites of a special PAN-based graphite fiber were evaluated by testing the fiber's tensile properties in an epoxy matrix. Representative strand samples were taken from 30 spools (~4 kg) of single-end, 1500-filament fiber to make over 5000 fiber/epoxy strand specimens using the filament-winding process. Characteristics studied were fiber uniformity, strength and modulus distributions at room and liquid nitrogen temperatures, stress-strain behavior, the effect of strain rate on fiber strength, and acoustic emission during tensile loading to failure. Liquid nitrogen temperature and various strain rates had no significant effect on fiber tensile properties. (auth)

2378 (UCRL-75278) LOW TEMPERATURE THERMOPHYSICAL AND MECHANICAL PROPERTIES OF HIGH PURITY PLATINUM-25 w/o IRIDIUM ALLOY. Foley, R. J.; Jelinek, F. J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Feb 1974. 8p. (CONF-740509-3). Dep. NTIS $4.00.

From fifth international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

The low temperature properties of a platinum-25 w/o iridium alloy were evaluated in the temperature range of 4°K to 300°K. The high purity material was synthesized by consumable arc melting and subjected to a series of cold-work and aging opera-

tions to obtain a high strength, machinable alloy. Values are presented for the thermal contraction and thermal conductivity between 4°K and 300°K. These measurements were performed using fused silica dilatometry and longitudinal steady-state methods, respectively. Mechanical strength data are reported at 20°K and 300°K. In all cases, the material used was 50% cold worked and aged at 973°K for five hours. (auth)

2379 (UCRL-75630) INFLUENCE OF THERMOMECHANICAL TREATMENT ON THE TENSILE PROPERTIES OF A PLATINUM–25 WT% IRIDIUM ALLOY. Foley, R. J.; Root, G. S.; Hauber, J. R.; Moak, D. P.; Pfeifer, W. H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Apr 1974. 18p. Dep. NTIS $4.00.

Platinum is significantly strengthened by alloying with iridium. When an application requiring high strength at room temperature arose, a Pt-25 wt% Ir alloy was chosen as a good compromise of strength and workability. The alloy was synthesized by consumable arc melting, hot worked at 1343°C, tensile tested at room temperature, and subjected to chemical analysis, metallographic examination, and limited hardness determinations. The tensile tests were first made under two different conditions of cold work following a water quench from the hot-work temperature. An absence of work hardening and a significant reduction in yield strength with increasing cold work were found. Adding an aging step of 5 hr at 700°C, strength increases. Subsequent cold work showed another decrease in strength, and reaging restored the strength and provided the highest strength levels. Maximum strength for Pt-25 wt% Ir can be achieved by a series of cold-work and aging operations. (auth)

Physics

2380 (AD-769460) X RADIATION FROM HIGH-ENERGY DENSITY EXPLODED WIRE DISCHARGES. Mosher, D.; Stephanakis, S. J.; Vitkovitsky, I. M.; Dozier, C. M.; Levine, L. S. (Naval Research Lab., Washington, D. C. (USA)). Oct 1973. 11p. (NRL-MR-2666). NTIS $2.75.

Exploded wire discharges of tungsten and titanium driven by a high power pulse generator have been used to produce intense X-ray continuum and line radiation. A calibrated LiF crystal spectrograph recorded the radiation spectrum in the 3 to 25 keV range. More than 20 J of X-radiation are emitted in this photon energy band by tungsten plasmas in less than 50 nsec. The source of emission is less than 1 mm in diameter and about 3.5 cm long. (auth)

2381 (BDX-613-887(Rev.)) REMOVAL OF INSULATION FROM MULTICONDUCTOR WIRE TAPE USING A CARBON DIOXIDE LASER. Horn, R. T. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 26p. Dep. NTIS $4.50.

Use of a carbon dioxide laser for removing insulation from multiconductor wire tape was investigated. A process to remove insulation from single wires was developed. Microscopic examination and emission spectrographs were used to evaluate process results. (auth)

2382 (BDX-613-992) FERRITE-CORE TRANSFORMER BONDING AND POTTING. Final Report. Kirk, W. J. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1974. Contract AT(29-1)-613. 66p. Dep. NTIS $6.50.

Methods were developed for maintaining thermal stability in inductors enclosed in ferrite pot cores and encapsulated into assemblies. Satisfactory bonds between the core halves were obtained with EA934 adhesive at processing temperatures to 80°C. However the force applied to the core interfaces during bonding is critical. Ferrite toroid and pot-core test coils encapsulated in rigid epoxy exhibited large inductance losses after potting despite the application of a thin layer of silicone rubber over the core surfaces. These losses were significantly reduced by adding 68 parts by volume (pbv) of Beta Eucryptite to the epoxy, thereby approximately matching the thermal coefficient of the encapsulant to that of the ferrite, approximately 10 μm/m/°C. Satisfactory impregnation of small pot-core coil windings was obtained with filler concentrations to 46 pbv; however, additional work will be necessary to obtain adequate impregnation with higher filler concentrations. (auth)

2383 (BDX-613-1016) ULTRASONIC WELDING OF ELECTRICAL TERMINATIONS. Stittsworth, D. E. (Bendix Corp., Kansas City, Mo. (USA)). Dec 1973. Contract AT(29-1)-613. 26p. Dep. NTIS $4.50.

Ultrasonic welding of electrical terminations is being investigated. Activity includes equipment evaluation and modification, weld tip design, and weld schedule certification on four different material combinations. The ultrasonic welding process has not been fully evaluated, but a potential for future production program applications is indicated. Aluminum and copper in varying thicknesses and combinations were tested. (auth)

2384 (BDX-613-1042(Rev.)) SOLDER SLEEVES. Ensor, J. R. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 22p. Dep. NTIS $4.25.

Solder-sleeve terminations were prepared and tested to establish the equipment and techniques necessary to use solder sleeves in production of cables and rack-and-panel assemblies. Based on the results of electrical, mechanical, and environmental tests of both solder-sleeve and hand-soldered joints, the use of solder sleeves is considered a suitable alternative to hand soldering for many applications. Potential cost savings and improved product consistency are indicated. (auth)

2385 (BDX-613-1066) TEN-BIT, SAMPLE AND HOLD OR PEAK HOLD CONVERTER. Grant, S. E. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1974. Contract AT(29-1)-613. 5p. Dep. NTIS $4.00.

2386 (BDX-613-1080) CONTROL OF ELECTROSTATIC DAMAGE TO SOLID STATE DEVICES. Technological Spinoff Report. Kirk, W. J. Jr.; Carter, L. S.; Waddell, M. L. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1974. Contract AT(29-1)-613. 24p. Dep. NTIS $4.25.

Static voltages generated on human bodies by normal movement of assembly personnel can degrade or destroy many solid state devices not normally expected to be susceptible to damage from such a source. An energy-storage model of the human body was developed and used to determine the levels of static voltage that degrade various devices. A system was assembled and used to continuously monitor and display the level of static voltage on an operator. The additional problem of static voltages created by solvent-spraying was studied and the benefits of varying the solvent volume resistivity were verified. (auth)

2387 (BDX-613-1085(Rev.)) EFFECT OF RAPIDLY CHANGING VOLTAGES ON THICK-FILM RESISTORS. Final Report. Bennett, A. G. (Bendix Corp., Kansas City, Mo. (USA)). May 1974. Contract AT(29-1)-613. 29p. Dep. NTIS $4.50.

Permanent resistance changes in thick-film resistors are linked to dv/dt sensitivity by this study conducted to determine the mechanisms responsible for these undesirable effects. The resistor is viewed as a network of circuit elements, and an extension of previous theories is proposed to relate the effects of rapidly changing potentials to increased stress on the microscopic distributed capacitances and resistances that comprise thick-film structures and cause resistance reduction resulting from dielectric breakdown and particle fusion. (auth)

2388 (BNWL-SA-3204) DYE STUDIES THROUGH USE OF ADVANCEMENTS IN AN AERIAL OPTICAL MECHANICAL IMAGING SYSTEM. Eliason, J. R.; Foote, H. P. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1970. Contract AT(45-1)-1830. 21p. (CONF-700348-1). Dep. NTIS $3.25.

From Northwest Scientific Association annual meeting; Salem, Oregon, USA (27 Mar 1970).

2389 (CEA-CONF-2470) SLOW-ELECTRON SPECTROSCOPY APPLIED TO THE STUDY OF SURFACES. Lecante, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France)). [nd]. 75p. (In French). (CONF-730226-2). Dep. NTIS (U. S. Sales Only) $5.75.

From meeting of the center of scientific and technical actualization on the present methods of study of gas-surface interactions; Lyon, France (6 Feb 1973).

An in-depth review is given of the study of surfaces using slow-electron spectroscopy. The sources and excitation processes are described. The electron relaxation process is then considered. The physical magnitudes attained by electron spectroscopy are outlined. The methods for the analysis of the different physical magnitudes are described. 109 references. (JSR)

2390 (CEA-CONF-2471) AUGER-ELECTRON SPECTROSCOPY. Ionization-Loss Spectroscopy. Appearance-Potential Spectroscopy. Riwan, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 – Gif-sur-Yvette (France)). 1973. 47p. (In French). (CONF-730226-3). Dep. NTIS (U. S. Sales Only) $4.50.

From meeting of the center of scientific and technical actualization on the present methods of study of gas-surface interactions; Lyon, France (6 Feb 1973).

An in-depth review is made to show the essential aspects of the physical mechanisms which govern the formation of Auger electrons and their emission. With the use of Auger electron spectroscopy data can be obtained on the first atomic layers and on the detection of the surface constituents. The ionization loss spectroscopy and apparition potential spectroscopy have more limited applications to the study of surfaces but can furnish sup-

plementary data to the results from the spectroscopy of Auger electrons. 72 references. (JSR)

2391 (CEA-CONF-2537) GARNET FILMS CHARACTERIZATION. Challeton, D.; Gay, J. C. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. d'Electronique et de Technologie de l'Informatique). 6 Oct 1973. 14p. (CONF-730994-1). Dep. NTIS (U. S. Sales Only) $3.00.

From conference on magnetic bubbles; London, England, UK (4 Sep 1973).

The methods are described for determining the characteristic parameters of garnet films which have been grown by liquid phase epitaxy (L.P.E.) and hydrothermal epitaxy (M.E.). The measured properties are: film thickness, film thickness variations, domain width of stripe domains in zero bias field, bubble collapse diameter, bubble collapse field, characteristic length, magnetization and wall mobility. The technique for determining the films defects is presented. (auth)

2392 (CEA-CONF-2547) PARAMAGNETIC EXCITON DYNAMICS STUDIED BY MEASUREMENTS OF NUCLEAR RELAXATION TIMES T_{1D} AND T_{1p}. Devreux, F.; Nechtschein, M. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Recherche Fondamentale). 1973. 4p. (CONF-730857-1). Dep. NTIS (U. S. Sales Only) $3.00.

From Colloque AMPERE; Bucharest, Romania (28 Aug 1973.

2393 (CONF-730476-1) TUNNEL MINING AND CONSTRUCTION ACTIVITIES. Flanges, W. G. (Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nev. (USA)). 1973. 7p. Dep. NTIS $3.00.

From American Institute of Mining Engineers meeting; Las Vegas, Nevada, USA (25 Apr 1973).

2394 (COO-3284-3) RESEARCH ON TURBULENT DIFFUSION. Final Report. Corrsin, S. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Mechanics and Materials Science). 16 Mar 1974. Contract AT(11-1)-3284. 12p. Dep. NTIS $4.00.

The principal research problems pursued under this contract were (a) experiments on a nearly homogeneous turbulent shear flow, (b) experiments on diffusion of scalar contaminant in isotropic turbulence, (c) experiments on diffusion of scalar contaminant in a turbulent boundary layer, (d) computer modeling of diffusion in both isotropic turbulence and homogeneous turbulent shear flow, (e) theoretical analysis of fluid material line growth in homogeneous turbulence, (f) preliminary experimental and theoretical studies of the propagation of a concentration interface across an isotropic turbulence. Summaries of some of the results are given. (MOW)

2395 (COO-3285-9) CRITICAL PHENOMENA AND RENORMALISATION GROUP FOR OUTSIDERS. Koevesi-Domokos, S. (Johns Hopkins Univ., Baltimore, Md. (USA). Dep. of Physics). May 1972. 58p. Dep. NTIS $6.00.

The following topics are discussed: (1) critical phenomena, critical exponents, and inequalities, (2) theoretical models preceding the renormalization group approach, (3) general ideas of the renormalization group approach, and (4) explicit calculations of the renormalization group transformations. (MOW)

2396 (LA-5408-MS) HIT: A MONTE CARLO TARGET-COVERAGE ROUTINE. Beckman, R. J.; Dowler, T. W. (Los Alamos Scientific Lab., N. Mex. (USA)). Mar 1974. Contract W-7405-eng-36. 6p. Dep. NTIS $4.00.

HIT is a Monte Carlo routine to estimate the expected coverage of either a rectangular or elliptical target when it is impacted by an effects circle with radius R. The general Monte Carlo technique is discussed and a listing of the routine is given. (auth)

2397 (LA-DC-72-745) RANDOM PACKING OF EQUAL AND UNEQUAL SPHERES IN TWO AND THREE DIMENSIONS. Vischer, W. M.; Bolsterli, M. (Los Alamos Scientific Lab., N. Mex. (USA)). Dec 1973. Contract W-7405-eng-36. 33p. Dep. NTIS $4.75.

2398 (LBL-2243) APPLICATION OF VELOCITY-SELECTIVE FREEZE-PUSHING TO THE SEPARATION AND CHARACTERIZATION OF AIR-BORNE SOLID PARTICULATE MATTER IN AIR POLLUTION SAMPLES. Shih, T. T.; Donaghey, L. F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1973. Contract W-7405-eng-48. 24p. (CONF-740311-3). Dep. NTIS $3.25.

From American Institute of Chemical Engineers national meeting; Tulsa, Oklahoma, USA (10 Mar 1974).

A new method for sampling and characterizing air-borne solid particulate matter in air pollution samples is described. The method utilizes the phenomenon of velocity-selective freeze-pushing of particulate matter during controlled solidification of organic liquids to selectively separate particles by differences in their interfacial physical properties. The theoretical basis of this phenomenon is discussed with respect to the separation factor, k*. An analytical sampling and characterization apparatus is described for particulate matter separation. Experimental results of the separation of graphite and hematite particles with thymol using zone chromatographic separation is described. (auth)

2399 (MHSMP-74-1) MECHANICAL AND FRICTIONAL BEHAVIOR OF SEVERAL HMX/ESTANE BASED EXPLOSIVES. Van Velkinburgh, J. H. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Jan 1974. Contract DA-11-173-AMC-487(A). 150p. Dep. NTIS $10.50.

For Univ. of California, Livermore.

Friction tests and accelerometer-instrumented skid and vertical drop tests were done on five HMX/Estane formulations. Accelerometer-instrumented tests used 23-lb, 11.00-inch diameter and 292-lb, 25.64-inch diameter hemispherical billets. Accelerometer records are discussed in relation to billet mechanical behavior. Friction tests are discussed. (auth)

2400 (MHSMP-74-5-B) SHORE GAUGE STUDY. Montague, J. L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1973. Contract DA-11-173-AMC-487(A). 8p. Dep. NTIS $4.00.

A brief study was conducted to determine the capabilities of three different Shore gauges (The Constant Load Durometer Type A-2, The Conveloader with Constant Load and Highest Reading Durometer Type A-2 and The Quadrant Style Durometer Type 00) and their effectiveness while testing various silicone formulations used at Pantex. (auth)

2401 (NVO-474-2) STRUCTURAL AND FREE FIELD SEISMIC MEASUREMENTS OF THE ZONIA MINE BLAST, ARIZONA. Navarro, R. (Geological Survey, Las Vegas, Nev. (USA)). Feb 1974. Contract AT(29-2)-474. 45p. Dep. NTIS $4.00.

The largest high explosive detonation in the United States was conducted in the Zonia Mine, Arizona on April 19, 1973, at 165942.8 GMT (calculated). The 2.07 kt of ammonium nitrate with 6 percent fuel oil was arranged in 32 charges detonated with a total delay time of 155 milliseconds. The explosion produced a seismic signal with a body wave magnitude (M_b) of 4.5 that was recorded by 12 temporary seismic stations operated by the U. S. Geological Survey and 8 permanent stations. The stations ranged in distance from 0.42 km to 587.5 km. The attenuation rate of the observed peak ground motion velocity amplitudes varied as the 1.54 power of the distance. The explosion produced less ground motion than expected at close-in distances (less than 32 km), but the recorded ground motions were equivalent to those of a single charge of 2 kt at distances beyond 32 km. (auth)

2402 (PTB-ME-4) DETERMINATION OF PITCH OF SCREW THREADS. Part I. Kochsiek, M.; Lerch, J. (Physikalisch-Technische Bundesanstalt, Braunschweig (F.R. Germany)). Feb 1974. 89p. (In German). Dep. NTIS (U. S. Sales Only) $7.50.

2403 (RFP-Trans-149) KINETICS OF PROCESS FOR DISSOLVING A SOLID MATERIAL UNDER CONDITIONS OF ITS IDEAL MIXING IN A CONTINUOUS-FLOW APPARATUS. Aksel'rud, G. A.; Guberman, B. N. Translated from Khim. Mashinostr. (Kiev); No. 15, 53-58(1972). 5p. Dep. NTIS $3.00.

2404 (RT/PROT-(73)29) DESCRIPTION OF THE PROGRAM CFRS. Lazzeri, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy). Div. Sicurezza e Controlli). 11 Oct 1973. 23p. (In Italian). Dep. NTIS (U. S. Sales Only) $4.25.

The CFRS program was written in order to compute the floor response spectra in a building. The earthquake is given by means of its power spectral density; the program can compute: (a) acceleration spectrum of a linear oscillator with an arbitrary power spectral density in stationary and not stationary conditions, (b) amplification factors of the acceleration assuming a white noise to represent the power spectral density, (c) amplification factors of the acceleration with an arbitrary power spectral density distribution. (auth)

2405 (SLA-73-982) TRANSIENT BEHAVIOR OF CIRCULAR FOIL HEAT-FLUX GAGES. Keltner, N. R.; Wildin, M. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 52p. Dep. NTIS $5.75.

An approximate analytical model of the transient response of a circular foil heat-flux gage to a step change in incident radiant heat flux is described. The model has been checked experimentally. The effects of geometrical design changes on the transient response of a copper body-constantan foil gage are analyzed. An example which illustrates the use of the model in conjunction with simple calculations or numerical convolution techniques to estimate errors in measurements of rapidly varying heat fluxes is presented. (auth)

2406 (SLA-73-997) PACKING AND INSTALLATION INSTRUCTIONS FOR SANDIA LABORATORIES/NASA/DFVLR ROCKET PAYLOAD PARACHUTE RECOVERY SYSTEM (P/N T19328-000). Widdows, H. E. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 60p. Dep. NTIS $6.00.

Complete handling, packing, and installation procedures for a rocket payload parachute recovery system are discussed. (auth)

2407 (SLA-73-1034) METHODOLOGY FOR COMPUTATION OF INTERFACE PARAMETERS OF A HOT-WIRE EXPLOSIVE DEVICE FROM THE ELECTROTHERMAL RESPONSE ANALOG. Strasburg, A. C. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 29p. Dep. NTIS $4.50.

The transient pulse test for determining bridgewire interface parameters of a hot-wire explosive device produces an analog of resistance change as a function of time in response to a square wave electrical signal. Previously used approaches to interpretation of this analog have been based on establishing an electrical equivalent or graphical balance. A procedure has been devised to interpret the response signal using relatively simple electronic data processing equipment. The analog is reduced to mathematical expressions representing the initial and final states of the primary time constant. These expressions, together with test equipment calibration and variables data, allow direct computation of component parameters. The technique will facilitate development of a test data system requiring a minimum of operator effort and interpretation in data reduction. (auth)

2408 (SLA-73-1065) EFFECTS OF FUEL FIRES ON CONTAINED EXPLOSIVES CHARGES. Lee, D. O.; Donaldson, A. B.; Jones, H. M. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 14p. Dep. NTIS $4.00.

The results of an experimental study conducted to determine the effects of a fuel fire on charges of heavily confined He are reported. Of cases studied, weak points in the confining vessel allowed venting as the He started to decompose, and detonation did not occur. (auth)

2409 (SLA-73-1069) RESPONSE OF CARBON–CARBON RINGS TO AN AXISYMMETRIC IMPULSE: A MATERIAL INVESTIGATION. Walling, H. C.; Schamaun, J. T. (Sandia Labs., Albuquerque, N. Mex. (USA)). Dec 1973. Contract AT(29-1)-789. 13p. Dep. NTIS $4.00.

A circular CVD carbon-carbon felt ring is impulse loaded with an axisymmetric, sine-squared pressure pulse of about 3 μsec duration. The ring response is measured with strain gages and compared with theoretical predictions which use statically determined stress-strain laws. Reasonable experimental-theoretical agreement is shown for the first period of response. (auth)

2410 (SLA-73-5827) RESPONSE OF A FINITE CYLINDRICAL SHELL TO A COSINE IMPULSE OVER HALF ITS CIRCUMFERENCE. Forrestal, M. J.; Tucker, W. K.; Von Riesemann, W. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 12p. (CONF-740412-1). Dep. NTIS $4.00.

From fifteenth structures, structural dynamics, and materials conference; Las Vegas, Nevada, USA (17 Apr 1974).

The elastic response of circular cylindrical shells with free ends loaded by a cosine impulse over half its circumference is examined experimentally and analytically. Aluminum shells with two geometries were loaded by magnetically propelled composite flyer plates consisting of 32 mils of polyethylene and 6 mils of soft aluminum. The momentum of the flyer plate was measured with pin switches, and the momentum delivered to the cylinders was obtained by rigid body motion measurements. Circumferential straintime histories at the cylinder midlengths and 180 degrees from the peak impulse intensity were obtained and compared with results from finite element computer codes. (auth)

2411 (SLA-73-5927) TRANSIENT WAVEFORM REPRODUCTION ON HYDRAULIC ACTUATORS USING A NONLINEAR GAIN ESTIMATION TECHNIQUE. Hunter, N. F. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 15p. (CONF-740415-2). Dep. NTIS $4.00.

From 20th annual technical meeting and equipment exposition of the Institute of Environmental Sciences; Washington, District of Columbia, USA (28 Apr 1974).

2412 (SLA-73-5931) MODERN TRENDS IN ENVIRONMENTAL TESTING. Clark, A. J. Jr. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1 Feb 1974. 16p. (CONF-740415-1). Dep. NTIS $4.00.

From 20th annual technical meeting and equipment exposition of the Institute of Environmental Sciences; Washington, District of Columbia, USA (28 Apr 1974).

2413 (SLA-73-5934) COMPARISON OF SHOCK SPECTRA AND THE LEAST FAVORABLE RESPONSE TECHNIQUES IN A TRANSIENT VIBRATION TEST PROGRAM. Witte, A. F.; Smallwood, D. O. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1974 14p. (CONF-740415-4). Dep. NTIS $4.00.

From 20th annual technical meeting and equipment exposition of the Institute of Environmental Sciences; Washington, District of Columbia, USA (28 Apr 1974).

A test program is described which compares this method with shock spectrum techniques. Eight field events were reproduced at the input to a test item. The responses of several critical components were observed. The shock spectra of the eight field events were computed. An envelope shock spectrum and the mean plus three sigma spectrum were computed. The composite spectra were then encompassed or matched using two types of pulses — the "SHOC" pulse (an oscillatory type transient), and a half sine pulse. Four pulses (two SHOC pulses and two half sines) were then reproduced at the input to the test item and the responses were observed. Finally, the Least Favorable Responses were computed and reproduced at the critical components. The results of all the tests are summarized and compared. Results indicate that the SHOC pulse matching the mean plus three sigma spectrum and the Least Favorable Response technique provided the best tests which covered all the field data without excessive overtesting. (auth)

2414 (SLA-73-7068) METHODS USED TO MATCH SHOCK SPECTRA USING OSCILLATORY TRANSIENTS. Smallwood, D. O. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 12p. Dep. NTIS $4.00.

Several analog and digital methods now available for matching shock spectra with oscillatory type transients are reviewed and the merits of each discussed. The methods include WAVSYN, SHOC, sums of decaying sinusoids, fast-sine sweeps, modulated pseudo random noise, and the method of least favorable response. While the last method is not strictly a method for matching shock spectra, it is closely related. The discussion is limited to procedures for synthesizing the waveform. Additional parameters (in addition to the shock spectrum) which can be specified to limit the classes of functions available for performing a particular test are discussed. These include (1) limiting the duration of the transient, (2) requiring that the transient match the shock spectra for two values of damping, (3) specifying the ratio of the peak shock response and the peak input level, and (4) specifically excluding certain methods. (auth)

2415 (SLA-73-7069) LONG-LIFE, LOW-VOLTAGE, POWER THERMAL BATTERY. Baldwin, A. R. (Sandia Labs., Albuquerque, N. Mex. (USA)). 1973. 19p. (CONF-740407-1). Dep. NTIS $4.00.

From 26th power sources symposium; Atlantic City, New Jersey, USA (29 Apr 1974).

2416 (SLA-74-33) BLAST PREDICTIONS AND MICROBAROGRAPH MEASUREMENTS FOR TOOELE ARMY DEPOT TEST, FINAL REPORT. Reed, J. W. (Sandia Labs., Albuquerque, N. Mex. (USA)). Feb 1974. Contract AT(29-1)-789. 25p. Dep. NTIS $3.25.

2417 (SLA-74-93) TECHNIQUE FOR TESTING THE TENSILE STRENGTH OF THERMOCOMPRESSION BONDS. Carlson, G. A. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 20p. Dep. NTIS $4.00.

A technique is described for testing the tensile strength of thermocompression bonds using stress waves generated by pulsed electron beam deposition. The technique has been used to test the strength of bonds prepared using different bonding parameters. Tensile strengths of 1 to 5 kbar are indicated for the bonds tested. (auth)

2418 (SLA-74-101) LARGE APERTURE ELECTROOPTIC PHOTOGRAPHIC SHUTTER. Phipps, G. S. (Sandia Labs., Albuquerque, N. Mex. (USA)). Apr 1974. Contract AT(29-1)-789. 17p. Dep. NTIS $4.00.

Electrooptic shutters have been fabricated for experimental and special purpose applications. Few have been constructed for general photographic use because of the availability of simpler, more desirable devices. The lack of a two-inch aperture mechanical shutter capable of fast, reliable actuation prompted an investigation of other possibilities. This report describes the theory, construction, and problems associated with the use of a PLZT shutter in ar imaging system. (auth)

2419 (SLA-74-112) AIRCRAFT-VELOCITY MEASUREMENT THROUGH RADAR-ALTIMETER ECHO WITH NONCOHERENT DETECTION. Williams, C. S. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 48p. Dep. NTIS $5.50.

2420 (SLA-74-117) ROCKET OPERATIONS PLAN. Australian Eclipse June 1974. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. Contract AT(29-1)-789. 67p. Dep. NTIS $6.50.

The temperature structure and density distribution of the solar corona from the limb out to about one solar radius above the limb will be measured during the total solar eclipse of June 20, 1974. The measurements will help to understand the physical processes of energy transfer from the photosphere outward into the solar corona and the solar wind. Exoatmospheric observations will be made by a high resolution spectrograph, which will measure the width of the Lyman-α line of neutral hydrogen in the solar corona and will be launched near Perth to an altitude of 320 km. Airborne and ground-based observations will be coordinated. (MCW)

2421 (SLA-74-6012) EFFICIENCY OF JET PUMPS. Temnov, V. K. Translated from Izv. Vyssh. Ucheb. Zaved., Stroit. Arkhitekt.; 10: No. 11, 155-160(1967). 7p. Dep. NTIS $3.00.

2422 (SLL-72-105) PHOTO-OPTICAL INSTRUMENTATION OF FLYER PLATE TESTS. VanDyke, D. P.; Rohwein, G. J. (Sandia Labs., Livermore, Calif. (USA)). Mar 1974. Contract AT(29-1)-789. 34p. Dep. NTIS $4.75.

Typical applications of the principal types of photo-instrumentation systems to flyer plate test setups are discussed and evaluated. General test guidelines are suggested, and specific lighting techniques and data reduction methods are given. (auth)

2423 (SLL-73-292) IMAGE ENHANCEMENT TECHNIQUES: ELECTRON MICROPROBE EXPERIMENT. Jones, H. D. (Sandia Labs., Albuquerque, N. Mex. (USA)). Mar 1974. 25p. Dep. NTIS $4.25.

Image enhancement techniques are applied in the processing of Mariner photographs, in the fields of optical holography, and nondestructive testing (e.g., acoustical holography). The theory behind image enhancement techniques is reviewed, and is applied to electron microprobe data. A computer program is presented to process and display digital data in image form. (MCW)

2424 (UCRL-51515) COMPUTER MODELS FOR ANTENNAS. Miller, E. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jan 1974. Contract W-7405-Eng-48. 32p. Dep. NTIS $4.00.

An overview of wire-antenna computer modeling is given, with emphasis on the interface problem. The formulation and numerical-solution methods are summarized, and applications are demonstrated with numerous examples. 51 references. (auth)

2425 (UCRL-75145) EDP EDUCATION: AN ACUTE CRISIS. Kapur, G. K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Oct 1973. 14p. (CONF-740507-1). Dep. NTIS $4.00.

From national computer conference and exposition; Chicago, Illinois, USA (6 May 1974).

A corollary to Gresham's law is presented: because of their enormous number, poorly qualified programmers and analysts circulate more freely than—and will eventually replace—their well-trained counterparts. Two critical problems are examined: the shortage of well-qualified programmers and analysts, and the abundance of poorly trained and inefficient people. A remedy is suggested; the transformation of business data processing into a science by means of improved education and training. Four present sources of supply are considered: (1) private EDP schools, which try to teach too much too fast; (2) colleges and universities, where two manuals plus three programs equal one fully qualified data processing professor, and where courses in this field are utterly lacking; (3) manufacturer's schools, which teach the stringing together of instructions and concentrate merely on syntactical correctness; and (4) in-house training programs in which half-trained instructors teach the art of "quick-and-dirty" coding. Suggestions are made for improving education and training, including references to successful methods that have been adopted in some of the more innovative programs. (auth)

2426 (UCRL-75486) LIVERMORE PLAN: MANAGING THE INDUSTRIAL TRANSITION TO METRIC. Pearson, J. W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Feb 1974. 18p. (CONF-740601-1). Dep. NTIS $3.00.

From American society for testing and materials symposium; Washington, District of Columbia, USA (24 Jun 1974).

A changeover to the predominant use of the International System of Units is expected to be especially beneficial to LLL because it will allow all the many scientific and engineering disciplines to talk to one another in the same measurement language. The problem of managing the transition has special difficulties, however, because of the large investment in fabricating and laboratory test equipment based on the inch or on non-SI metric units, and because the largely one-off nature of fabricating for research support and prototype design precludes such benefits available to high-volume production industries as special purpose tooling and go/no-go gaging that do not use measurement units. The development of the transition management plan has become known as the Livermore Plan. The Livermore Plan consists of seven fundamental ideas that are to be used to guide the different organizational activities in developing their operating rules, plans and schedules. (MCW)

2427 (Y-1916) FIRE SPRINKLER NETWORK ANALYSIS PROGRAM. Blackmon, J. T.; Stickle, E. T. (Oak Ridge Y-12 Plant, Tenn. (USA)). 2 Apr 1974. Contract W-7405-eng-26. 95p. Dep. NTIS $5.45.

Hydraulically designed fire protection systems allow the designer to supersede the existing rules for pipe sizing. The advent of large industrial buildings, exhibition halls, high-rise buildings, and warehouses with their new techniques of high-piles storage have necessitated a change in philosophy from set rules to hydraulically designed systems. Computers assist in the design of systems and permit a more efficient use of a designer's time by reducing the tedious time-consuming calculations that are the natural result of using the hydraulically designed system. The n-dimensional Newton-Raphson solution technique is utilized to reduce computer time and the storage required for the solution of a problem. (auth)

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